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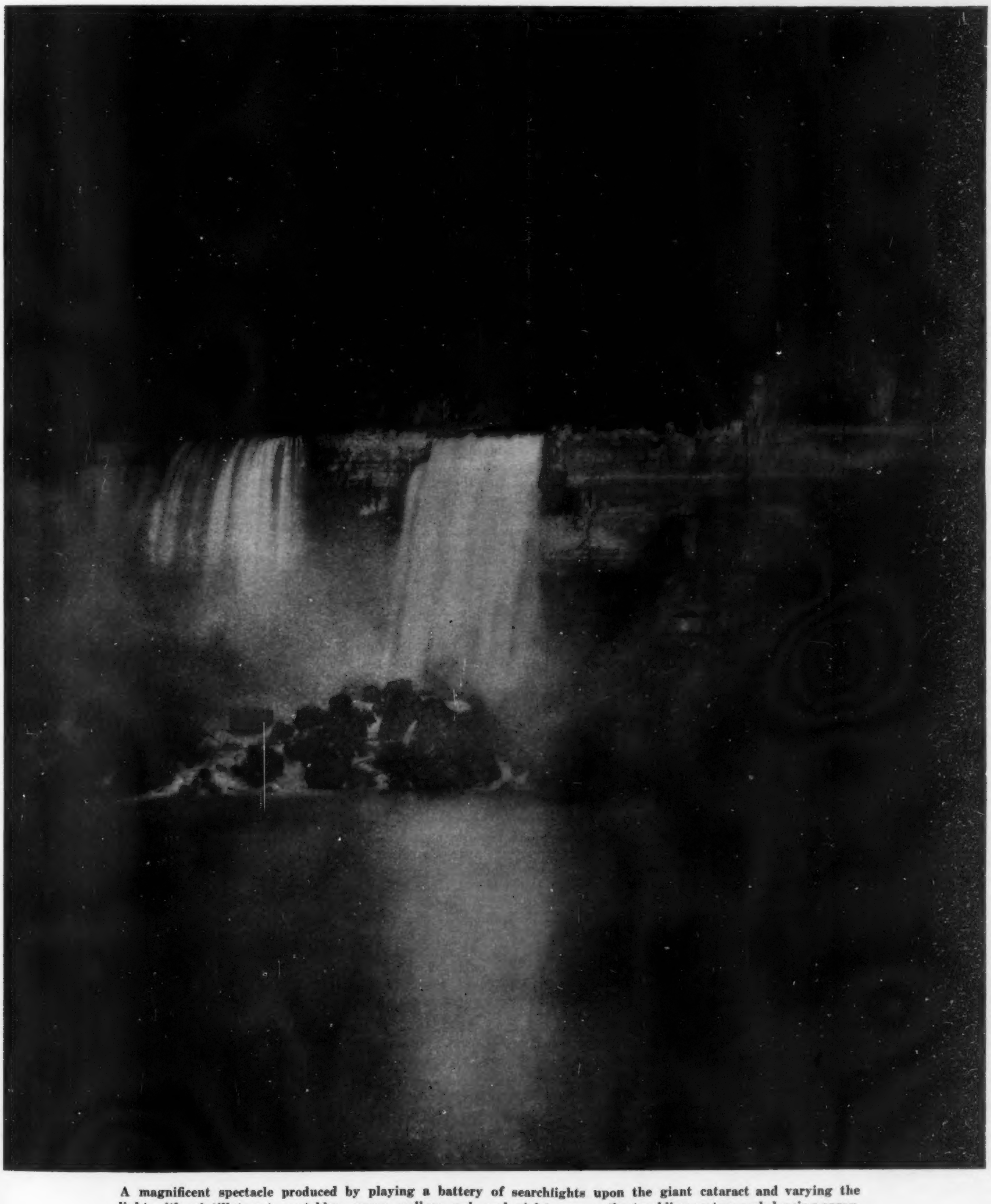

A magnificent spectacle produced by playing a battery of searchlights upon the giant cataract and varying the light with scintillators to cast blue, green, yellow, red, and violet rays on the tumbling waters and dancing spray.

ILLUMINATION OF THE BRIDAL VEIL FALLS OF NIAGARA

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately and in simple terms, the world's progress in scientific knowledge and industrial achievement. It seeks to present this information in a form so readable and readily understood, as to set forth and emphasize the inherent charm and fascination of science.

Will the Tungsten Lamp Raise Rates?

THE fear has been expressed that the increasing use of the wonderfully economical tungsten lamp will so greatly reduce the consumption of current as to render it necessary for the lighting companies to raise their rates in order to make a reasonable profit on the smaller output from the lighting stations. A 16-candle-power carbon filament lamp requires 56 watts for its operation, but a 20-candle-power tungsten lamp demands only 25 watts. This is equivalent to $3\frac{1}{2}$ watts per candle-power for the old as against $1\frac{1}{4}$ watts per candle-power for the new lamp. Hence, for the same amount of illumination in any city, if there were to be a complete substitution of tungsten for carbon lamps, there would be a reduction of, say, 60 per cent in the output of current necessary from the electric lighting station. If a given station sold in a year one hundred million kilowatt hours to its customers when they were using carbon lamps, the demand, if there were a general substitution of the new lamps, would be cut down to, say, forty million kilowatt hours. This would mean that 60 per cent of the generating plant would be standing idle, although the fixed charges would remain. Hence, it would seem at the first blush as though a company which had been charging a fair price to its customers on an output of a hundred million kilowatt hours would have to make an increase in its rates, if it wished to make the same profit on an output of forty million kilowatt hours.

As a matter of fact, we do not look for any considerable increase in rates; it is likely that such as may occur will be only temporary in character, and this for several reasons. In the first place, it will be found that the principles which regulate the economic effects of labor-saving inventions will operate with equal certainty in this matter of more efficient lighting. The labor-saving device has always resulted in a larger employment of labor, in a more efficient way. So, in the long run, the introduction of the cheaper and better lighting rendered possible by the tungsten lamp, will result in a largely increased consumption.

Another condition which will serve to offset the smaller consumption of the new lamp is the fact that the steady improvement in the standards of living shows itself markedly in the field of illumination. There is a constant demand for better lighting. From the day of the wood fire through the successive periods of the candle, the oil lamp, gas, the Welsbach burner, and the carbon electric light, there has always been a gradual use of the superior illumination, once it was provided. When people install the tungsten lamp, they almost invariably make use of more light than they were satisfied to use under the old method. So true is this that when one enters public buildings, stores, offices, or private dwellings in which the change from carbon to tungsten lamps has been made, one is invariably struck with the fact that the lighting is far more brilliant than formerly.

Another condition which tends to prevent any sudden falling off in the total demand for current is that the introduction of the new lights is gradual. It takes time for even so brilliant an invention as this to overcome the inertia of existing conditions, particularly in the early days of its introduction, and it is quite conceivable that the larger use of electric lighting will in itself, particularly in suburban and other residential districts, serve largely to offset the decreased total demand for current. To this must be added the fact that under existing conditions, the lamps cost nothing to the user, whereas the customer not only has to buy the tungsten lamps, but he has no privilege of free renewals.

The Bunsen Centenary

OURS is the Golden Age of Science. But yesterday we saw the birth of wireless telegraphy; to-day we witness the first signal victory in the conquest of the air; and we wonder what the morrow will bring forth. So condensed has been the sequence of stirring events in contemporary history of science and the useful arts, that our sense of the wonders about us is perhaps almost in danger of being dulled by the very familiarity of these occurrences, and we may thus lose our appreciation of the spectacle of unprecedented human progress, in which it is our good fortune and privilege to be, not only witnesses, but actual participants. Indeed, the fact that we are not merely passive lookers on, but active workers, each doing his share, however modest, in the world's great work, is apt to foreclose the larger outlook from our view. We do well, in a moment of respite from our toil, to raise our eyes to the far horizon, and breathe in the spirit of our time. Inevitably we are thus led to look back into the past, to contemplate the avalanche growth of modern science, and to pay homage to the great pioneers through whose endeavors we have come into this great inheritance.

The current year marks the centenary of Bunsen, of whom Ostwald speaks as "the greatest inorganic chemist of the nineteenth century, since Berzelius."

Popularly, Bunsen is perhaps most widely known through two or three of his minor contributions to experimental science, to which his name has been attached. Among these are the smokeless burner, which has now invaded every laboratory and finds application for numberless other uses, and the modification of the Grove cell, in which a specially-prepared carbon electrode is used in place of the costly platinum. Perhaps not quite so well known is the fact that Bunsen is the originator of the bichromate cell, which may be regarded as a modification of the Bunsen element, in which chromic acid is used as depolarizer in place of the nitric acid. To physiological chemistry Bunsen has made an important contribution in the discovery of the ferric hydroxide antidote for arsenic poisoning. He is also the originator of the well-known "grease spot photometer." But these things are mere trifles as compared with Bunsen's greater creations, such as his pioneer work in the investigation of the chemistry of the blast furnace process, and the development of gas-analytical methods which arose largely out of this investigation; his electrolytic researches resulting in the isolation of the alkali elements rubidium and cæsium; his only, but brilliant research in organic chemistry: the study of the cacodyl compounds of arsenic, in the prosecution of which he was constantly exposed to danger from poisoning and explosion, and which left him permanently disabled by the loss of one eye. But by far his greatest gift to science is undoubtedly the method of spectrum analysis. This originated as an outgrowth of those "flame-coloration tests" devised by Bunsen with the aid of the non-luminous flame of his burner, and now familiar to every beginner in chemistry. Probably Bunsen himself at the time did not dream of the far-reaching consequences which his work in spectrometry would bring in its train. From it flowed among other results the explanation of the Fraunhofer dark lines in the solar spectrum, and the whole field of astral chemistry was opened, giving the lie to the somewhat rash statement of August Comte: "It will never be possible to determine the chemical composition of the stars."

It is quite hopeless to attempt to give in a short compass even an approximate idea of all the fruit which spectroscopy has borne to physical science, pure and applied. Nor is this all, for there is every indication that some of the most important developments of the future, giving us that long sought-for insight into molecular mechanics, will derive their experimental basis from observations made by the aid of the spectroscope.

Is the Mile-a-Minute Motor Boat at Hand?

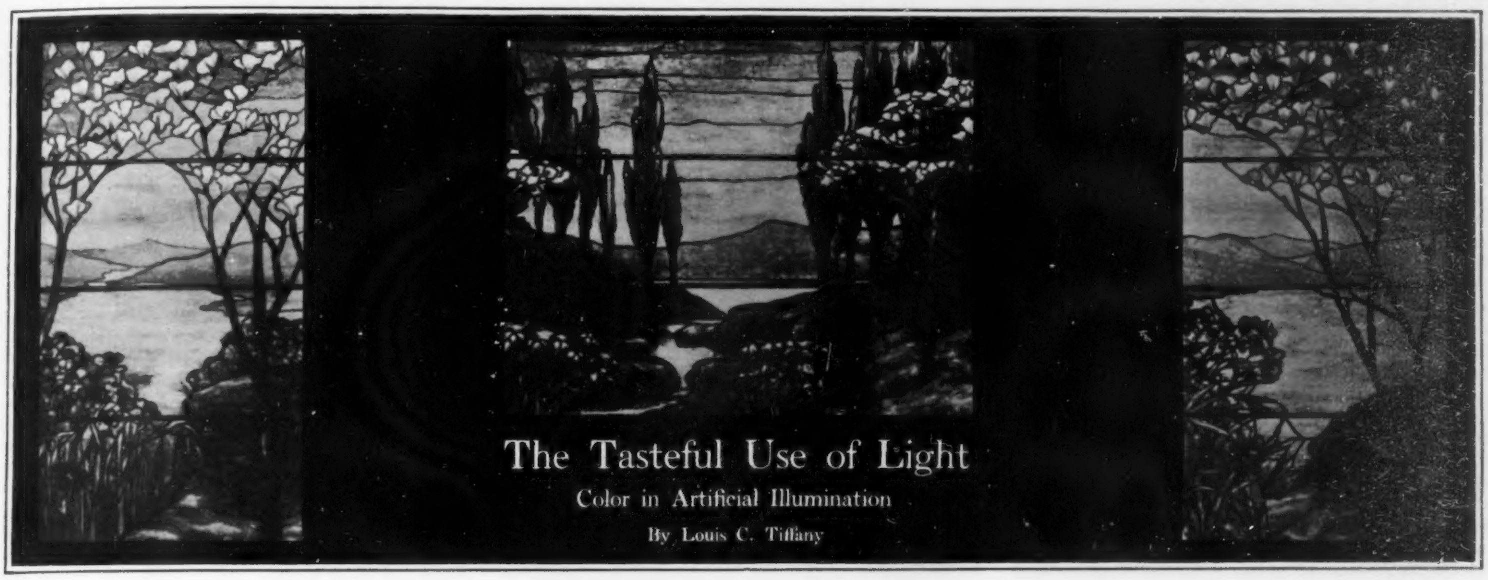
CABLE dispatches from abroad state that an 800-horse-power motor boat has shown on trials a speed of 49.5 knots, or nearly 60 miles per hour. If this be true we must be within sight of the mile-a-minute motor boat. Of the one hundred and five boats entered for the next Monaco meeting, none will attract so much attention as the two hydroplane English racers entered in the unlimited power class. One of these, "Maple Leaf IV," has been specially designed with a view to capturing the International Cup, at present held by "Dixie II." The other, "Brunhilde," may also be seen in American waters this summer. Her unique design was furnished by W. H. Fauber, formerly of Chicago.

For the past two years the struggle has been between hydroplanes and displacement boats, the former being supplied by France and the latter by England. For a long distance race the "Wolseley-Siddeley," and later the same boat modified and known as "Ursula," have been unconquerable. But for the mile and kilometer sprints, the 160 horse-power of the hydroplanes "Brasier-Despujols" in 1910, and the "Duc" in 1909 have been more than a match for the 800 horse-power contained within the orthodox hull of the British racer. Last year the hydroplane "Brasier-Despujols" established a record of 45.3 miles an hour over a short distance, with the comparatively low horse-power of 160.

The original type of hydroplane as presented to the British Admiralty by Ramus in 1872, patented by Thornycroft in 1877, and later adopted by French engineers, was almost a flat-bottomed boat with a single step; but she advanced, when in motion, with a series of bounds of such violence that it was frequently a difficult matter for the crew to prevent being pitched overboard. This pounding of the water was destructive of even the most strongly-built hulls, and several of the French boats have had to be withdrawn with a broken back after only three or four days' racing. Later the French have developed a stepless type of hydroplane, the first of which gave very satisfactory results at the last Monaco gathering. The Fauber type is in a class by itself, for instead of one deep step, the "Brunhilde" has five rather shallow steps and a pure displacement type of bow. Naturally, the boat has a V-section forward, the V opening out until the boat is almost flat fully astern. Previous Fauber hydroplanes taking part in the Monaco races have proved that this type of boat has none of the disagreeable pounding which makes the original type of hydroplane an abomination to the crew in anything but dead calm water. Instead of the 800 horse-power motors fitted in last year's "Ursula," this year's craft will only have 400 horse-power, developed by two Wolseley-Siddeley motors of 6 cylinders each. If the "Brasier-Despujols" could develop 45 miles an hour with only 160 horse-power, it is confidently declared in certain quarters that "Brunhilde," with more than twice this power, will exceed 60 miles an hour. This, however, remains to be seen.

The second English boat in the unlimited class is "Maple Leaf IV," designed by Sir John Thornycroft. This also is a hydroplane, the exact nature of which has not yet been made known. Her power plant consists of two motors developing 400 horse-power each, or a total of 800 horse-power. One of these motors was prepared for and fitted in last year's "Maple Leaf," which was sent to Monaco; but, owing to an accident at the last moment, they were never seen in competition. The same motor has been prepared for the new boat, and another one of the same type built to accompany it. Monaco will serve as a valuable training ground for the "Maple Leaf," enabling her owners to put her in proper trim and to obtain reliable data as to her possibilities in the later race against the American champion. In a preliminary trial "Maple Leaf IV" is stated by the press to have attained a maximum speed of 49.5 knots.

The French have not built an unlimited power racer to meet the English boats. Instead they have been satisfied to prepare a second-class racer having a four-cylinder motor of not more than 6.1 inches bore. The hull is of the hydroplane type. As it is impossible under the bore limitation to obtain more than 200 horse-power out of the "Brasier-Despujols" motor, it may seem at first sight that victory will fall to the English craft in all the open events. But Brasier and Despujols are not men to bow down quietly even in the face of the strong force brought against them; moreover, there is always present the possibility of breakdown of these super-engined craft at the critical moment.



The Tasteful Use of Light

Color in Artificial Illumination

By Louis C. Tiffany

IN the consideration of the question of color in artificial illumination, the effects upon the eyes which are finally to receive the light are the most important factors. All the light that we can see is colored, and the nature of the color occasions a wide range of sensations, which in turn directly and indirectly have a profound effect upon the mental state. Illumination which does not take account of color effects is in a lesser degree like a scheme of decoration in black and white, sufficient and satisfying only to those who are color blind. Until recently the lighting engineer has had at his disposal practically only light of a single color, but one has only to examine the marvelous effects now produced upon the stage by the use of colored lights to realize in some degree what could be done in general lighting if colored lights could be more generally used. The anatomists tell us that we have in our eyes three sets of sensitive nerves, one of which perceives light of long wave length, another an intermediate wave length light, and the third a very short wave length light; and that we are conscious of intermediate colors by two sets of nerves being acted upon at once. If light of one color comes to the eye in considerable amount or for a long time, the nerves used to see that color become temporarily fatigued and to some extent lose their acuteness of perception for the time being, while the nerves which perceive the complementary color become more active and temporarily more acutely perceptive of their proper color if it should then be presented to them. On account of this inherent and universal demand of the mind for constant change and variety, we enjoy the sensation of the extra excitement of the nerves produced by looking alternately at complementary colors, and the more the color sense is trained and developed the more keenly sensitive it is to the contrasts of complementary colors, so that the trained artist sees and enjoys contrasts of color more toned with black or white than the untrained person who can perceive and enjoy only the contrasts of purer, cruder colors. The trained or educated eye has also the power to some extent to see colors which are to the uneducated eye quite invisible; the last colors to be perceived are those farthest away from the red and of the spectrum. Undoubtedly the educated eye can see some shades of ultra-violet light which upon the ordinary eye make no impression.

Although the great majority of persons are not artists with trained color senses, and although some are even partially blind to colors, the vast majority have eyes with a fair degree of sensitiveness through the whole range of visible color, and consequently the laws of color must be obeyed in all artificial illumination or the results can never be wholly satisfactory.

It is proverbial that "colors seen by candle light do not look the same by day" and the question at once arises whether or not it would be desirable to have our illumination at night exactly the same as by day. The primitive means of lighting by burning wood, by candles and then in later times by gas, all give a light which is yellowish and quite different in character from sunlight, and mankind has from time immemorial expected that his artificial light at night would be yellowish and different from sunlight and has made everything to be seen at night of such quality and texture and color that it would be seen to the best advantage by a slightly yellowish light. Whether or not it would be possible even if it were preferable to change all this by a system of lighting which would be identical with daylight, must remain for the present an open question. Our hereditary need is for an artificial light which shall be slightly yellow. Yellow is the color of brightness and mirth. Through hereditary association of ideas yellow suggests to the mind the idea of brightness, brilliancy, or sunshine, while blue suggests cold, and by suggestion gives one the sensation of cold, while red on the contrary gives in the same way a sensation of warmth. A room lighted with reddish light gives distinctly the sensation of warmth, while a bluish illumination gives with equal distinctness the feeling of cold. Of two exactly similar rooms one of which is lighted with blue and green lights and the other with red and yellow lights every one will involuntarily select the warm light in a cool climate or the blue room in a warm climate. It seems that red is the primitive color, for a child is capable of perceiving red, the color of longest wave length, at an earlier age than other colors; and as mental development progresses, the ability is acquired to perceive colors of shorter wave length, and the continued development in this respect is seen in adult life in the work of most artists and persons of normal development who as their color senses become more perfectly developed constantly grow to prefer more and more the cooler colors of shorter wave length and also to prefer colors mixed with black or white, that is, grayer or of lower tone, to crude ones, and the less glaring contrasts of low tones to the contrast of the cruder colors. This is generally true, although some with advancing age or whose optic nerves, for some other reason, become less vigorous, are able to enjoy only the cruder colors. The suggestion of the primitive color red is that of primitive desire for warmth, while blue appeals to the more developed intellectual faculty of refined thought and delicate sensation. Blue impinges more on adjacent colors than any other color, and acts more as a modifying or toning color; when blue is placed next to other colors it appears to the eye to be carried more into the adjacent colors, than they are into it. It is for this reason that the finest old windows show a predominance of blue.

In lighting, as in every other appeal to the senses contrast is the important means of emphasizing and intensifying the sensation; for this reason contrast must be very sparingly used, as strong contrasts tend to weary the senses of the beholder and a slightly varied repetition is one of the most important means by which effects can be heightened in color as well as in sound.

The lighting and shading of exterior places by awnings, etc., is not generally given enough thought. Red awnings are frequently placed where shade and coolness are the ends to be attained, and these are sacrifices to tone decorative effect. One of the most important principles in illumination as in decoration generally is that the primary necessity is to consider the senses affected first and the scheme of decoration afterward; the scheme of decoration or lighting must be suited to the needs of the senses, for the senses cannot be adapted to suit the scheme. The most fatal mistake in a scheme of lighting is to make it evident that the lighting is the principal thing considered; lighting that is obtrusive is offensive; wherever possible the lighting should be done by proper reflection rather than by direct rays; the effect of this reflection is the same as that of mixing white or black with the crude colors; it lowers the tone and makes it softer and more agreeable.

One of the best illustrations of improper lighting is in many theaters, where in the endeavor to obtain a rich and agreeable effect dark red has been used to such an extent that a large proportion of the light is absorbed, making it necessary to provide lights that are unnecessarily bright, thus defeating the very end which the color was used to attain. Lighter tones of decoration in colors which will reflect more light and absorb less, lowers the demands upon the lighting devices whatever they may be and diffuse in a more agreeable way the light that is used.

Although in some respects these remarks may be open to criticism, I believe the fundamental principles set forth to be essentially sound, for they are in accord with the observations of a long course of work and thought on the subject. In one respect at least, and one that is frequently lost sight of, they are certainly true; the sense affected by illumination is not simply that of sight, but all the senses are directly or indirectly appealed to and they must all be considered.

Combating the Sleeping Sickness

A SHORT time since we described in the SCIENTIFIC AMERICAN the work of the British government in conjunction with the Royal Society in connection with the eradication of the sleeping sickness. The work of the commission in British Uganda has been attended with complete success, two camps having to be closed owing to the demise of all old patients suffering from this scourge, and the absence of fresh cases. The propagation of this epidemic was attributed to the fly *Glossina palpalis*. The districts which were known to be pestered with this disease-carrier were carefully mapped out, and by careful investigation it was found possible to ascertain the regions of its activity. Owing to the rigorous methods advocated by the commission, and the energy with which such were taken up it was rendered possible to remove the inhabitants from the suspected zones and to stamp out the fly by extreme measures.

Just recently, however, it has been discovered that the *Glossina palpalis* is not the only germ carrier. A death occurred in England from the sickness, and a minute pathological examination revealed the disquieting news that the parasite was of a different character from that already ascertained. Inquiries showed that the victim had come from Rhodesia, from a district 400 miles south of the limits of the haunts of the *Glossina palpalis*, and further investigation resulted in the discovery of another species of the tsetse fly, the *Glossina morsitans*, as being the vehicle of infection, while it was also found that several other persons in Rhodesia were suffering from the same malady. Should such ultimately prove to be the case, the definition of the localities favored by the *morsitans* will be somewhat difficult as it is found over a much wider area. The region in which the case occurred has been searched for the *palpalis* but without success. It is not believed to come so far south, so that suspicion of the *morsitans* seems to be well founded. Possibly the former is a migratory insect and if such is the case this unsuspected attribute will be closely investigated. Thanks to the measures adopted in Uganda it is hoped that this scourge will be completely eradicated from the country within a short time, and it is suggested that a commission should be dispatched to Rhodesia to stamp out the scourge while still in the incipient stage, so that the country may not be so extensively affected as have been the Congo, Uganda, and other parts of the continent.

Light and Shadows

Ministering to Eye Comfort by Modern Methods

By E. C. Crittenden, Assistant Physicist at the Bureau of Standards, Washington

IN the brotherhood of engineers—those beneficent genii whose touch makes nature serve us with the least possible waste of her stores of energy—the "illuminating engineer" is a distinctly recent development. When our grandfathers sat by their tallow candles the problem of illumination was simple; for all that was required was to get enough light by which to see. Gas and electricity offer us the solution of that problem, but in their wake has come a multiplicity of new ones. "Let there be light" is not sufficient; we find that there may even be such a thing as too much light, or more often, light in the wrong place. We must realize that light in itself is not an end, but a means, a raw material. The mutual emulation of the gas and the electrical engineer has given us floods of this raw material, but what we want is not merely light, but the ability to see. That is, the light must be properly applied; hence the illuminating engineer.

When sources of light were feeble and the problem was simply to get enough light, those sources were naturally placed where they could send their beams freely in all directions, and this practice persisted when more intense sources were introduced. Consequently the first great evil which the illuminating engineer was called upon to remedy was the blinding glare of lamps shining straight into people's eyes. Such glare is a double evil. It is well known that it is extremely wearying and therefore aggravates weakness or ailments of the eyes, if it does not cause them. Besides that, it very materially reduces the effective illumination, so that much more light must be provided than would otherwise be necessary. The explanation for this is simple. In order that objects may be seen, light must come from them, enter the eye, and stimulate the optic nerve. But the eye exposed to the bright lamp in self-defense reduces its sensitiveness by drawing the iris over the pupil and also by reducing the activity of the nerve. This reduction of sensitiveness means that if an object is to be seen, more light must come from it than would be necessary if the eye were not thus trying to shut out the light. This effect can be shown by the simple experiment of placing a candle in the doorway of a dimly lighted room and trying to look past the candle into the room. With sources brighter than a candle the effect is more marked.

The remedy is obvious; we must have shields over our eyes or over the lamps. For indoor lighting a simple solution is found in hiding the lamps entirely, letting the light from them fall first on the walls or ceiling, whence it is diffusely reflected to illuminate other objects in the room. One method of accomplishing this which is often used in public buildings is "cove" lighting; the cove is a recess usually running entirely around the room near the ceiling in which lamps with reflectors are so placed that as much as possible of the light is projected upon the ceiling. This system is well suited for large rooms with arched ceilings, especially where the ceiling or the panels of the arches bear works of art or play an important part in the decoration of the room. A good example of the cove method of lighting is the main waiting room of the Union Station at Washington, of which a view is given herewith. The walls of this room are of white granite and the ceiling of ornamental plaster in white and gold. Inverted arc lamps are placed in the alcove of the balconies over the vestibules, their light being reflected partly from the small arches of the balconies and partly from the great arch of the main room.

Some of the advantages of the cove system will be emphasized by comparing the illustrations mentioned above with that of the south hall of the entrance pavilion of the Library of Congress where faulty illumination with bare lamps utterly ruins the effect of a splendid series of mural decorations. In this case cove lighting, or something equivalent, would be a striking improvement because the walls and ceiling are just the places where light is desired, while a comparatively low general illumination would answer all purposes for which the hall is used.

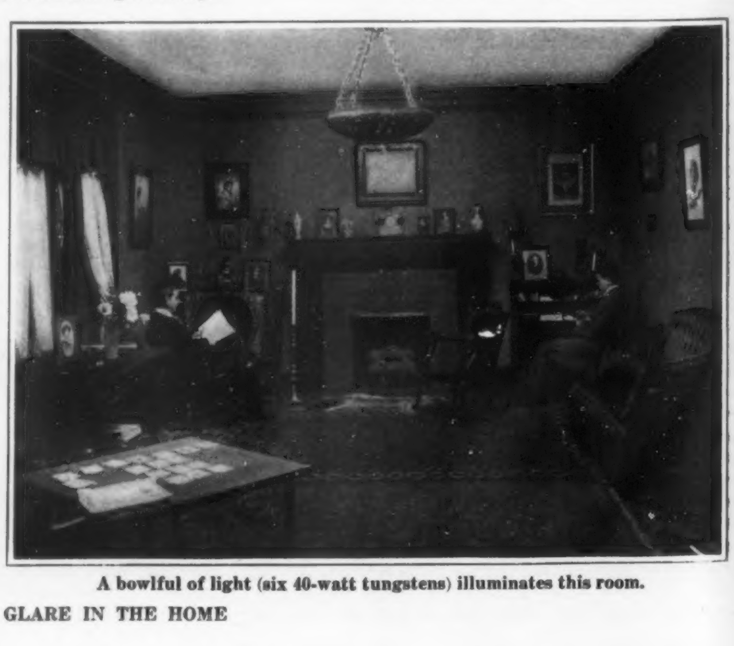
The great advantages claimed for indirect lighting are the perfect uniformity, and the avoidance of shadows as well as of glaring lamps. These features make it applicable for auditoriums and public halls and for draughting rooms where shadows are troublesome. The cove system has, however, seldom proved satisfactory except in rooms where a rather low intensity is sufficient or in such special cases as those mentioned. There are several reasons for this. In the first place its efficiency is necessarily low because an excessive amount of the light is thrown where it is really useless. The light must be reflected once or possibly several times before it reaches the plane where illumination is important. The whitest of walls will absorb at least 20 per cent of the light falling upon it, and at every reflection the wall takes its toll. The system must be well designed in order to get half as much light down to the working plane as would be furnished by the same lamps in direct lighting. Besides all this loss there is a further decrease in the effective illumination because the eye being surrounded by brightly lighted walls adjusts itself for high intensity so that actually more light must be furnished in the working plane than would be needed there if the general illumination were lower. Still, with our brilliant modern lamps light has become so cheap that we can well afford some loss in return for better distribution of the remaining light, and if low efficiency were its only fault cove lighting would find extensive use.

Two serious objections arise from that very uniformity which has been mentioned as being the great virtue of indirect lighting. It may be *too* uniform. The eyes, tired from the bright light on the page or the drawing before them, involuntarily seek relief by turning to some less brilliant object. Now, if on all sides they meet white walls and uniform brightness no rest is obtained and fatigue comes quickly. Another criticism arises from the absence of shadows. If we are to illuminate a painting in which the artist fixes the balance of light and shade and makes the light appear to come from some definite direction, diffused illumination is desirable; but wherever form or relief is important shadows are necessary. Perfectly diffused light takes all the vigor from a statue, just as it takes expression from the face. Can you imagine a portrait taken with uniform light from all sides? The photographer's methods are instructive; he uses diffused lighting on all sides, but contrives to add to this a component of directed light which brings out the desired expression. In some cases where cove lighting has been unsatisfactory a similar treatment has been found effective. The cove can be used for a general illumination of moderate intensity, while a few direct lighting sources serve to produce soft shadows and give direction to the light. In an auditorium or lecture room, for example, if the light is entirely diffused, it is practically impossible to see the expression of a speaker's face, and the addition of a small amount of directed cross-light makes a remarkable improvement.

Another method of lighting without exposing the eye to the glare of

Dining-room lighted with four 60-watt tungsten lamps.

Living-room illuminated with two-light fixture by reflection from the ceiling.



A bowlful of light (six 40-watt tungstens) illuminates this room.

METHODS OF AVOIDING GLARE IN THE HOME

the lamp is the so-called "direct-indirect," in which the lamps are placed above glazed panels in the ceiling. These panels may be simply skylights, serving for day light as well as artificial lighting, or they may be especially constructed for the latter alone. In either case concentrating reflectors of some sort must be provided around the lamps to throw as much of the light as possible down through the glass. To give a good distribution the glass must be frosted or colored. Consequently some light is lost in it, and, of course, if dirt collects on the glass the loss is still greater. In efficiency of utilization of the light, as judged by measurements of illumination, this method is not far different from the cove system, but the effect produced is generally far more restful and pleasing. This system of illumination was first introduced by C. E. Knox, who installed it in the Engineering Societies Building in New York. Other examples of this kind of lighting are found in the Senate Chamber and in the House of Representatives at Washington. This method is also used in the Washington Union Station for the ticket lobby shown in the background of the illustration. The arched roof of the lobby is almost entirely of glass, and at night light is furnished by incandescent lamps outside of the glass. A striking extension of this method in which lights, as well as glass, of various colors are used for decorative effect as well as for illumination, has been recently made in the auditorium and the banquet hall of the Allegheny County Soldier's Memorial at Pittsburg, Pa.

Another modification capable of extensive application is due to the great advance which has been made in the manufacture of prism glass designed to throw the light in any desired direction. In a studio, for example, it may be desirable to have a strong but diffused light on paintings hung on the walls, while a much less intense light is needed for the central portion of the room. By placing lamps above a ceiling of prism glass one can obtain such distribution as is desired without the hideous reflectors ordinarily used for the purpose. Moreover in the case of a studio with a skylight, the same prism glass ceiling will serve to distribute the natural as well as the artificial light.

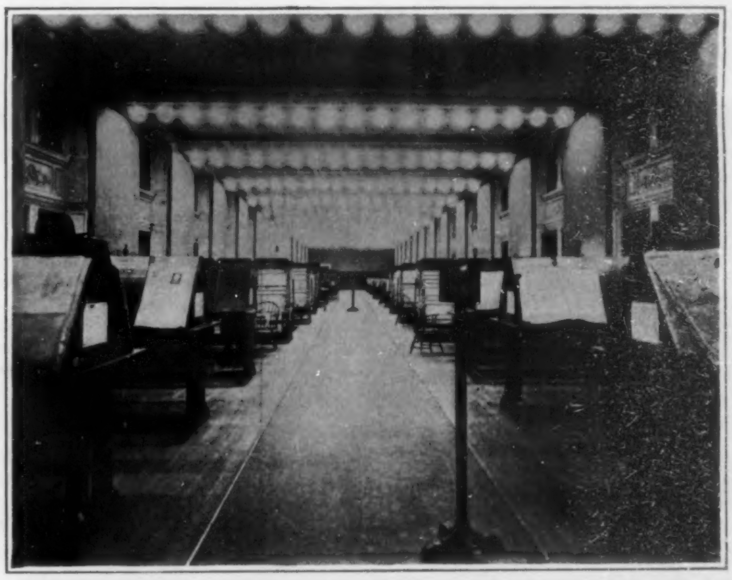
This "direct-indirect" system seems to be a decided improvement over the cove system, but like it, requires special construction and is applicable only within a field limited chiefly to public or semi-public buildings. The development of successful indirect lighting by fixtures applicable to the ordinary building, and therefore useful in the home, the store and the office, as well as in churches, auditoriums and other public buildings, has been slow in coming. It has been hastened of late by the introduction of the highly efficient but painfully brilliant metallic filament lamps, which have so markedly emphasized the evils of glare and at the same time have cheapened the production of light so that the losses in indirect illumination are a less serious objection. By using these high-efficiency lamps in combination with reflectors scientifically designed for high reflecting power and proper distribution of the light, and adaptable for ordinary chandeliers, excellent results are being obtained. The fixture system permits the placing of lamps so as to get the light where it is needed even with a flat ceiling, and the fixtures themselves, if well designed, add materially to the appearance of a room. This system therefore lends itself to the artistic lighting of a ball room as well as the effective illumination of an office or a store. In cove lighting the intention is to conceal entirely the source of light, and special pains are generally taken to avoid any unevenness which would call attention to the location of the source. In fixture lighting the more successful designers have made no attempt to secure such perfect uniformity on the ceiling, and have planned the reflectors so as to concentrate most of the light in regions almost directly over the lamps. This gives the advantage of getting most of the light thrown down to the working plane after only one reflection, so that a fairly high efficiency can be secured without using white side walls, and sufficient variation in intensity is secured to avoid the fatiguing effect of cove lighting. Moreover, shadows are not so entirely obliterated and objects are given a more natural appearance.

For the design of indirect lighting fixtures there are no classic precedents. Some attempts have been made to copy ancient lamps, but the treatment of the problem as an entirely new one is more sincere and has produced happier results. A variety of designs are on the market, ranging from the plain round reflector to the most ornate patterns for ball rooms, hotels and theaters. Some idea of the effects obtained may be

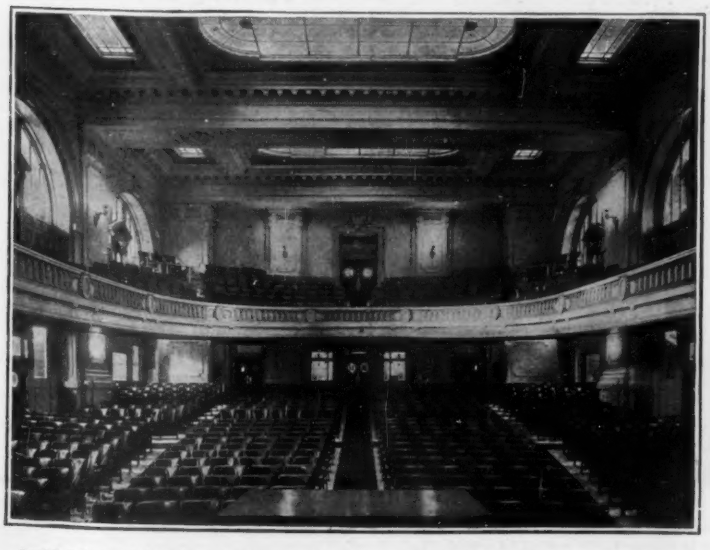
(Continued on page 388.)

Faulty lighting in south hall of entrance pavilion, Library of Congress.

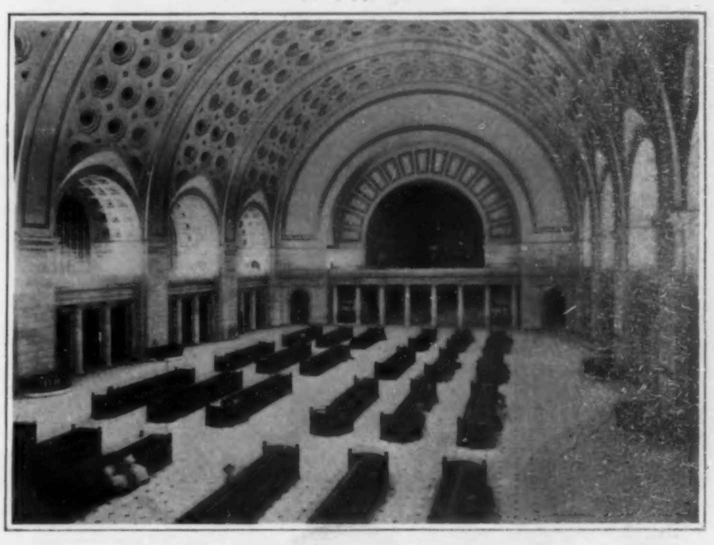
Indirect lighting fixtures used in the Hamilton National Bank, Chicago.



Direct illumination in the newspaper-reading room of the Library of Congress.



Artificial skylight illumination; auditorium of the Engineering Societies Building.



Cove system of illumination; waiting-room of the Union Station, Washington, D. C.

GOOD AND BAD LIGHTING OF PUBLIC BUILDINGS

Good Coal and Poor

Purchase of Coal on the Basis of Its Heating Value

By J. A. Holmes, Director of the United States Bureau of Mines

FOR many years the "unbusiness-like" farmers of this country have been purchasing their fertilizers on the basis of the percentages of the available nitrogen, or potash, or phosphate each contained, while the "business men" have long continued the purchase of coal for their factories and residences on the basis of its looks or its general reputation.

But during the past few years the fuel resources of the country have been investigated more carefully than ever before, and with special reference to the development of methods by which the different kinds of coal can be used with greatest efficiency, and can be purchased on a basis fair alike for the producer and consumer. As a result of this movement for greater fuel efficiency, the general government, the larger cities, and the larger manufacturing, power, and lighting companies of the country are now purchasing their coal on the basis of its heating value, as indicated by chemical analyses.

COAL AND ITS COMPOSITION.

Few materials so extensively used are at the same time so little understood as is coal. The dictionaries define it; the geologists describe its origin from vast accumulations of vegetable matter, and tell us how under different conditions during past ages this vegetable matter has been transformed into different types of coal. The chemists show this coal to be composed mainly of carbon, hydrogen, and oxygen, with smaller quantities of nitrogen, sulphur, and other mineral substances. But the meaning of this information in the language of fuel efficiency is another and more intricate proposition.

The chemist reports the results of his examination in a form illustrated by the following analyses of four types of coal. The first column of figures (a) represents a good anthracite coal; the second (b) a high-grade bituminous coal (Pocahontas); the third (c) a low-grade bituminous coal, and the fourth (d) a typical Northwestern lignite.

Analyses of Types of Coal.

	(a) Anthracite (Furnace Coal of Good Quality).	(b) High Grade Bituminous Coal (Pocahontas).	(c) Average Low Grade Bituminous Coal.	(d) North Dakota Lignite.
Moisture	3.33	2.8	10.83	36.13
Volatile matter	3.27	18.0	36.24	29.28
Fixed carbon	84.28	73.9	39.75	29.55
Ash	9.12	5.3	13.18	5.04
Sulphur	0.60	0.64	4.53	0.59
B.T.U., "as received"	13,351.00	14,550.00	10,816.00	7,326.00
B.T.U., "dry"	13,810.00	14,970.00	12,130.00	11,473.00

INTERPRETATION OF COAL ANALYSES.

The owner of a large manufacturing establishment, who for the first time is presented with a bunch of such analyses, and finds his coal bill accompanied by a bill to cover the cost of these analyses, naturally inquires what it all means. The following notes may be of service to him.

The *moisture;* this may be partly inherent in the coal and partly external from the snow, rain, or dew, but in any case it appears to have no heat value, and the less of it he has to pay for the better.

The *volatile matter* is not fully understood; it is given off as gases in the early stages of the burning; it is known to be of real value, and furnishes the long flame so useful under certain conditions, though a varying proportion of this volatile matter appears to be inert, and of no heat producing value. Some of it is lost in burning, and its loss is intimately associated with the smoke nuisance in all our cities, to escape which, as this volatile matter is greater or less, we must use one or another of the different types of mechanical stokers. The analysis of the coal aids in determining the type of stoker best adapted to its efficient burning, but generally there must be supplemental tests in the furnace before a definite conclusion can be reached.

The *fixed carbon* represents the chief fuel value of the coal, as the process of combustion is largely the development of heat through the oxidation of this carbon and a portion of the hydrogen and carbon in the volatile matter through their combination with the oxygen of the atmosphere introduced through the draft.

The *ash* is a necessary but useless nuisance; and when it melts or forms a slag on the grate bars, as it is especially apt to do when high in iron, lime, and other alkalies, it becomes a troublesome nuisance by seriously interfering with the draft and efficient burning of the coal. Therefore, other things equal, every one prefers a low-ash coal, and especially one with an ash that does not slag readily in the furnace. This preference is not lessened by the fact that the chemist cannot fully explain either why the ashes of certain coals slag more seriously than those of other coals, nor how this evil can be satisfactorily prevented or counteracted in the furnace.

The *sulphur* found in coal usually occurs in the form of iron pyrites, sulphate of lime, alumina and magnesia, combined with hydrogen and carbon, or free sulphur. In best coals it is usually less than one per cent. In lower grade coals it occasionally constitutes as much as five or six per cent of the total weight. It is usually regarded as objectionable, but rarely proves seriously injurious to the boiler tubes unless accompanied by considerable quantities of moisture. When combined with iron (in pyrites), it is chiefly objectionable because of its tendency to fuse or form a slag on the grate bars which may seriously interfere with the draft, and, therefore, with the efficient combustion of the coal.

But the tendency of the chemist of to-day is to pass over all the above vexatious and unsettled problems, and explain to the layman that the *British thermal units (B.t.u.'s)* represent the real fuel value of the coal—though they do not always accurately do so. A "B.t.u." is a heat unit, or the quantity of heat required to raise a pound of water one degree in temperature (from 39 deg. to 40 deg. F.). The heat unit used in countries other than Great Britain and the United States is called a calorie, and represents the quantity of heat required to raise a gramme of water one degree in temperature (from zero to 1 deg. C.).

HOW THE BRITISH THERMAL UNITS ARE DETERMINED.

In the analyses given above, the anthracite coal is described as containing 13,351 B.t.u.'s "as received," or 13,810 B.t.u.'s "dry coal" (dried at 105 deg. F.). This means that each pound of this anthracite coal "as received" contained 13,351 British thermal units, or that a ton (2,000 pounds) would contain 26,702,000 B.t.u.'s. The number of these thermal units in any given coal may be calculated from its chemical composition; but it is usually determined in an instrument called a calorimeter; and the calorimeter now generally used in the United States is the Emerson, Atwater, or Williams modification of the Mahler, or Mahler-Berthelot bomb calorimeter. The Emerson type of this calorimeter and the method of using it are illustrated in the accompanying photographs.

One gramme of finely pulverized coal is burned in this calorimeter in the presence of an excess of pure oxygen. The coal is ignited by the electric heating of a small platinum wire passing through the coal placed on a tray within the calorimeter. The bomb of the calorimeter is immersed in a given volume of water. The increase in the temperature of this water due to the burning of this one gramme of coal is accurately measured by a thermometer, read through a telescope by the observer, who remains a sufficient distance from the calorimeter to prevent its temperature being affected by the warmth of his body.

PURCHASE OF COAL ON SPECIFICATION.

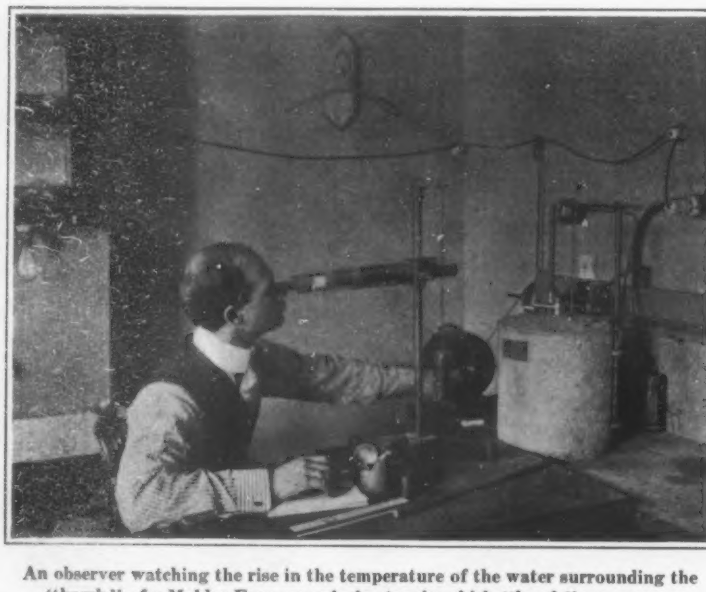
Under the old method of purchasing coal it was usually prescribed that the coal should be that usually sold under a certain standard trade name, or "as good as" that standard coal, and "free from slate." But there was no means provided for the measurement of slight, or even serious, variations from this standard, except as these variations might become apparent to the eye.

In the purchase of coal on specifications, by means of chemical analyses, even slight variations in the quality of the coal are easily detected, and corresponding variations in its value easily determined.

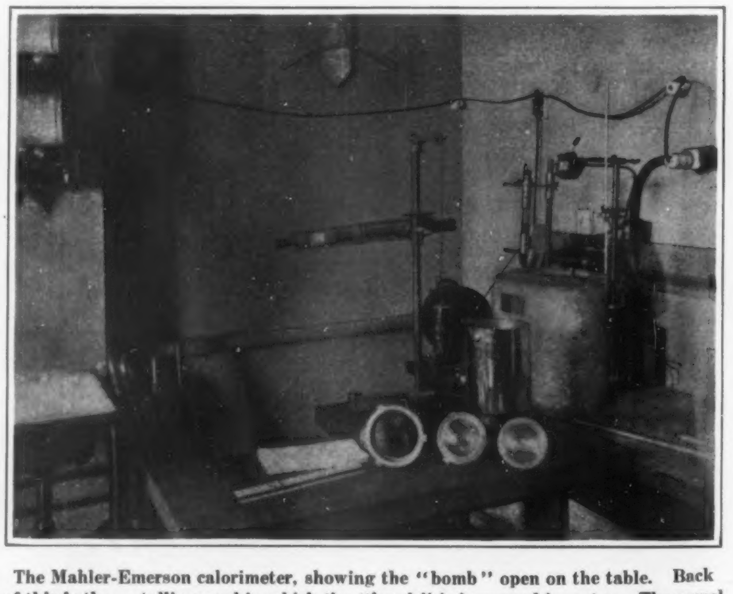
A rational plan of procedure is as follows:

In the establishment of a new power plant for manufacturing, lighting, or heating purposes, the furnaces installed should be selected with special reference to the efficient burning of the coals locally available; the engineer in charge then issues a description (including chemical analyses and B.t.u.'s) of the standard of coal he desires to purchase for his plant, and asks for bids on the basis of this standard, un-

(Continued on page 388.)



An observer watching the rise in the temperature of the water surrounding the "bomb" of a Mahler-Emerson calorimeter, in which "bomb" one gramme of dry, pulverized coal has been burned.



The Mahler-Emerson calorimeter, showing the "bomb" open on the table. Back of this is the metallic vessel in which the "bomb" is immersed in water. The vessel is placed inside a felt-covered casing. The water is stirred and its temperature measured.

CALORIMETERS USED AT THE UNITED STATES BUREAU OF MINES

Correspondence

A Correction

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of February 18th, you published an article entitled "New Methods and New Machines for the Farm." Among the illustrations that accompanied that article was one of the Hill pulverizer, the title of which read "A Traction Ditcher for Work in Very Wet, Sticky Ground." This machine is not intended for that purpose, but is a new self-propelled device intended to prepare alluvial soil for the planter. It pulverizes from five to fifteen acres of such soil per day, cutting 18 feet wide.

THE BUCKEYE TRACTION DITCHER COMPANY.

Findlay, Ohio.

The Emu

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of January 7th, 1911, I noticed a paragraph in an article, "Great Zoological Park," in which you state that the emu is now almost extinct. This statement is very misleading, as they still exist in very large numbers in north and northwest New South Wales, and practically all over Queensland, south and western Australia. I saw many hundreds myself last year while on a shooting trip in western Queensland. I am certain it will be very many years before they are extinct, as they are practically valueless.

G. H. ROWELL.

Boggabri, New South Wales, Australia.

Daylight Observations of Venus

To the Editor of the SCIENTIFIC AMERICAN:

In my article on "Locating the Pole by Daylight Observations of Venus," the first sentence of the last paragraph reverses the intended meaning of the sentence.

It reads, "When Peary was at the pole April 6th, 1909, Venus was favorably placed and could be seen."

It should read, "When Peary was at the pole April 6th, 1909, Venus was *unfavorably* placed and could *not* be seen."

Indianapolis, Ind. JOHN CANDEE DEAN.

A Letter from the Home of the Secretary Bird

To the Editor of the SCIENTIFIC AMERICAN:

I have read your interesting article on secretary birds, with the splendid photographs of them killing snakes. I have often seen them when I was living in the eastern portion of Cape Colony. There was usually a pair on the estate, and we would see them in the mornings performing their rounds over the veld looking for food. They are very graceful and handsome birds, and show up well in the distance on their long legs. I should not say that they equaled a horse in running. More like ten miles an hour their speed seemed to me. If you walked after them, they would increase their pace from a walk to a run, and finally take to their wings. If the wind was blowing from behind them, they had to face round first and take a short run against the wind before they could leave the ground. A useful hint for the Messrs. Wright for their aeroplanes, which I daresay they have already made use of. High up in the air it needs a trained eye to distinguish them from a vulture. It resembles somewhat the South American cariama, and is perhaps allied to it. The nests that I have seen have been on low trees like the Australian wattle or mimosa, at about ten or twelve feet from the ground, and it is interesting to notice the weaver birds with their curious and ingenious bottle-shaped nests, hung to keep out snakes, choose the same tree to build in, divining no doubt that they will be safer there from their enemies. The nests that I have seen are not so large as your article mentions. They are about three feet, I should say, in diameter, one and one-half feet thick, made chiefly of sticks, and without turf sods. I think it was a curious sight to me when I climbed up, looked in, and saw the tremendous youngster filling up the whole space—its large eyes, as big as mine, and with great eyelashes, unlike most birds. There had been two, but one may have been carried off by hawks. I have sometimes approached the nest when another bird has been sitting, or perhaps the male bird; and though I have stood just beneath and thrown up sticks to make it move, it has for long refused to stir, till at length its paternal affections being overcome, it has got on the edge of the nest, and given itself a push off into the air, leaving the contents to their fate. Its appetite is not exactly what one might call delicate, as the following bill of fare found inside a female will show: One tortoise, eight chameleons, twelve lizards of two species, three frogs, one adder, two locusts, two quails, besides other remains. It is popularly supposed to be strictly preserved by the law of the land, but this, however, is not the case, and many would like to see their extinction, as they kill numbers of the young partridges and hares. They are sometimes kept in captivity, but are difficult to rear, owing to the brittle nature of their long legs. I hope that these few notes will interest your readers.

T. B. BLATHWAYT (B.A. Oxford).

Cape Town, South Africa.

Some Points in Philosophy of Science

To the Editor of the SCIENTIFIC AMERICAN:

Ever since I can remember, I have favored science and scientific methods as opposed to metaphysical speculation, but for that very reason I have been led to dip rather extensively into metaphysics, and have reached the conclusion that most of its errors have been caused by basing trains of reasoning upon undefined or ill-defined notions.

In your issue of March 18th, you give extracts from an article mentioning four fundamental assumptions underlying science. First, that absolute truth exists; second, that we are part of it, though "we make all the errors, nature none;" third, that things have a real objective existence; fourth, that things are different from our sensual perception of them.

Now absolute truth means neither more nor less than complete knowledge; anything that is, is true. It is only when we contemplate it in relation to other things, that error creeps in. Absolute truth demands full knowledge of all the relations of the thing under consideration, and this involves the relations between all other things.

The second assumption is correct. We are a part of the world in which we live, and error is simply lack of comprehension.

The meaning of the third assumption depends on the meaning of "objective." We have no possible means of knowing that anything exists, apart from our perception of it; and so the only possible test for objectivity lies in sensual perception. Since we certainly do perceive things by the senses, these things certainly do have objective existence.

The fourth assumption is an error. The objective thing is exactly what the senses report—for that is all there is objective about it; but the senses are unable to perceive relations. The relations between things are ascertained mentally, and are subjective. Science is really engaged in discovering subjective, not objective laws—conditions of consciousness and experience—means by which we may foreknow, and to a great extent control, not only subjective phenomena, but also our actual sensual perceptions, or the objective.

The subjective character of mathematics is generally recognized, but the equally subjective nature of scientific hypotheses is almost as generally overlooked. The truth of a theory, like that of a mathematical proposition, depends solely upon its self-consistency—consistency in all its necessary relations, subjective and objective. The value of a theory is to a considerable extent independent of its abstract truth, depending merely upon usefulness. There has probably never been a more valuable theory than the mechanical theory of matter—heat, chemistry, etc.—although this theory is constructed in terms of the most crude, primary, and obvious generalized notions, formed from sensual experience.

In fact, the value of the mechanical theory has lain largely in this very obviousness, which enables it to be grasped by inferior and by undeveloped minds. In its endeavor to embrace all phenomena, this theory is now becoming so complicated, that for most purposes its ideas of substance and motion might well be replaced by those of force and direction; nor is it probable that all phenomena can ever be expounded even in these terms—not to mention that great unknowable in which all ultimate causes are hidden, and must remain hidden, until the conditions governing consciousness are radically altered.

Asheville, N. C. ALLEN G. MILLER.

Drawing the Charge—Our Cover Design

THE cover design of this issue is a reproduction from a painting by J. C. Chase, depicting an incident in the manufacture of coal gas for lighting and heating. It shows the emptying of the retorts at the works of the Consolidated Gas Company, at West Forty-second Street, New York, a procedure which is technically known as "drawing the charge."

Each retort receives a charge of about 300 pounds of bituminous "long flame" coal. The heat of the furnace under the retort reaches a maximum of 2,500 degrees. The process requires about four hours for each charge, and the heat in the retorts ranges from about 900 degrees at the beginning to some 2,000 degrees at the end of the four hours.

In the process of distillation the coal first cinters down somewhat, after which, as the heating is continued, volatilization begins. Numerous cells are formed in the coal, so that it assumes a porous structure and is ultimately converted into coke. The gases which are given off in the process escape upwards through the mass of coal, thence by a mouthpiece through the up-take pipe into the hydraulic main. The gas is cooled and is then drawn off by means of an exhauster and is passed through an extensive purifying plant, in order to free it from a number of impurities whose presence in the product would be objectionable. At the expiration of the four hours required for the complete conversion of the coal into coke, the doors of the retorts are thrown open. A certain amount of heavy volatile matters always remains in the retort in the process of distillation, and at the moment the doors are thrown open, this volatile matter, coming in contact with the air, bursts into flame and casts a lurid orange glare over the surroundings. Men in gangs of three or four now draw out the coke from the retorts by means of long rakes. This coke falls through open traps to a floor below, where it is cooled by streams of water. The red-hot coke on coming in contact with the water raises thick white clouds of steam enveloping the workmen so as to sometimes almost completely hide them from sight. The drawing of the charge completes the process, and the retorts are now ready to receive a new filling, after which the same operations are repeated as on the previous charge.

The Adoption of Greenwich Standard Time in France

ON February 10th, 1911, the French Senate passed a bill which makes Greenwich time legal in France. When the law goes into effect French time will become nine minutes and twenty-one seconds slower than it is now. In order to avoid the expense of altering charts and sailing instructions, the law will not apply to French naval or other vessels, and it is not likely that any change will be made in the *Connaissance des temps* and other French almanacs. French railways are now run by a standard five minutes slower than Paris time, and the clocks inside stations are regulated by this standard, while the clocks on the outside of the stations give the correct Paris time. This confusing system will be abolished, and both the exterior and the interior clocks will be regulated by Greenwich time, by which the trains will be run.

The French and British governments once came to a sort of informal agreement or understanding that France would adopt the meridian of Greenwich as a base of longitude and time, on condition that the metric system of weights and measures should be made compulsory in Great Britain. The British part of the agreement has not been carried out, and it is a curious circumstances that, while the French Senate was debating the adoption of Greenwich time, a demand for a standard of time varying with the season of the year was being made in Great Britain. The system of standard time sections, furthermore, is not used in Ireland or in India, and its abandonment was recently mooted in Germany.

In France, henceforth, Greenwich time, reckoned from midnight, will be the legal time for civil transactions, while Paris time, reckoned from noon, will be retained in the navy, merchant marine and astronomical observatories. France will thus be included in the Western European standard time section, with Great Britain, Belgium, Holland, Spain, Portugal and Algeria.

The Central European section, the time of which is one hour later than that of Greenwich, comprises Germany, Switzerland, Austria-Hungary, Italy, Norway, Sweden, and Denmark. The Eastern European section includes Bulgaria, Roumania, Turkey, Egypt, and East Africa, in all of which countries the standard time is two hours later than that of Greenwich. North America is divided into five sections: Intercolonial, Eastern, Central, Mountain and Pacific, having their standard time respectively four, five, six, seven, and eight hours earlier than that of Greenwich.

Heating the Home

Methods of Providing Warmth with Proper Ventilation

By James F. Martine

RESPONDING to the demand of the comfort-loving American, heating engineers of the United States have perfected systems for keeping the home warm that have become standard all over the world.

With assurance that the very best heating systems to be had are right at hand, it only remains to make intelligent application of the system best suited to the particular heating requirement. Upon the correct application and proper installation of an adequate heating system depend the comfort and, to a large degree, the health of the family, for some six to eight months of the year.

Yet, strange as it seems, but little personal attention is given to the details of the important matter of heating. Occasionally a preference is exercised for some particular system or method, but without due consideration of the adaptability of that system or method to heat the home properly and economically. It is more easy and customary to leave it entirely to some local heating contractor. There are exceptions, of course, but particularly in the case of new homes, most of the time, thought, and money are expended on design and ornamentation of the interior.

The preferences for some heating systems, and aversions to others, are based on popular fallacies that it is well to explode. Some prefer hot water heating, believing that because of the water it must give a moist heat. As a matter of fact, hot water heat in no way supplies moisture to the air. This will be appreciated by references to Fig. 1 in the accompanying drawing. The function of the water circulated is only to convey the heat to the various radiators, and as all joints, etc., must be watertight, it is not possible for the air to receive moisture from this source. The makers claim for hot water heating systems a more uniform heat, but not that it supplies moisture to the air.

Many are prejudiced against warm air furnace systems, and why? They say the incoming air brings dust and in passing around heating drums must draw gas and dirt through the radiator pipes into the rooms; also that contact of the air with iron of the heating drums consumes oxygen. As a matter of fact the heating drums do not become heated to a temperature necessary to consume oxygen. Note Fig. 3 showing the route the air takes to reach the rooms. It is impossible for gas to be drawn from this type of furnace into the rooms unless some part of the heating drum or furnace proper should crack or a joint spring open. Assuming that a certain amount of gas did reach the rooms, it would be more easily detected than a wide open gas jet. The chimney draft exhausting the gases from the furnace are always many times stronger than the slight air current passing around the heating drums and thence to the rooms. Therefore it is most unlikely that gas would reach the rooms from slight openings, and should it do so from large openings, prompt detection would follow.

Because of the stuffiness in overheated, poorly ventilated rooms, it is thought by some that steam heat uses up the oxygen in the air. Though steam heat is quite indispensable, some remedy would be welcomed. The cause is lack of proper ventilation, and is in no way due to the heating system. We know the composition of air in its natural state consists of oxygen twenty volumes, nitrogen seventy-nine volumes, and carbonic acid gas one volume, also a slight trace of watery vapor.

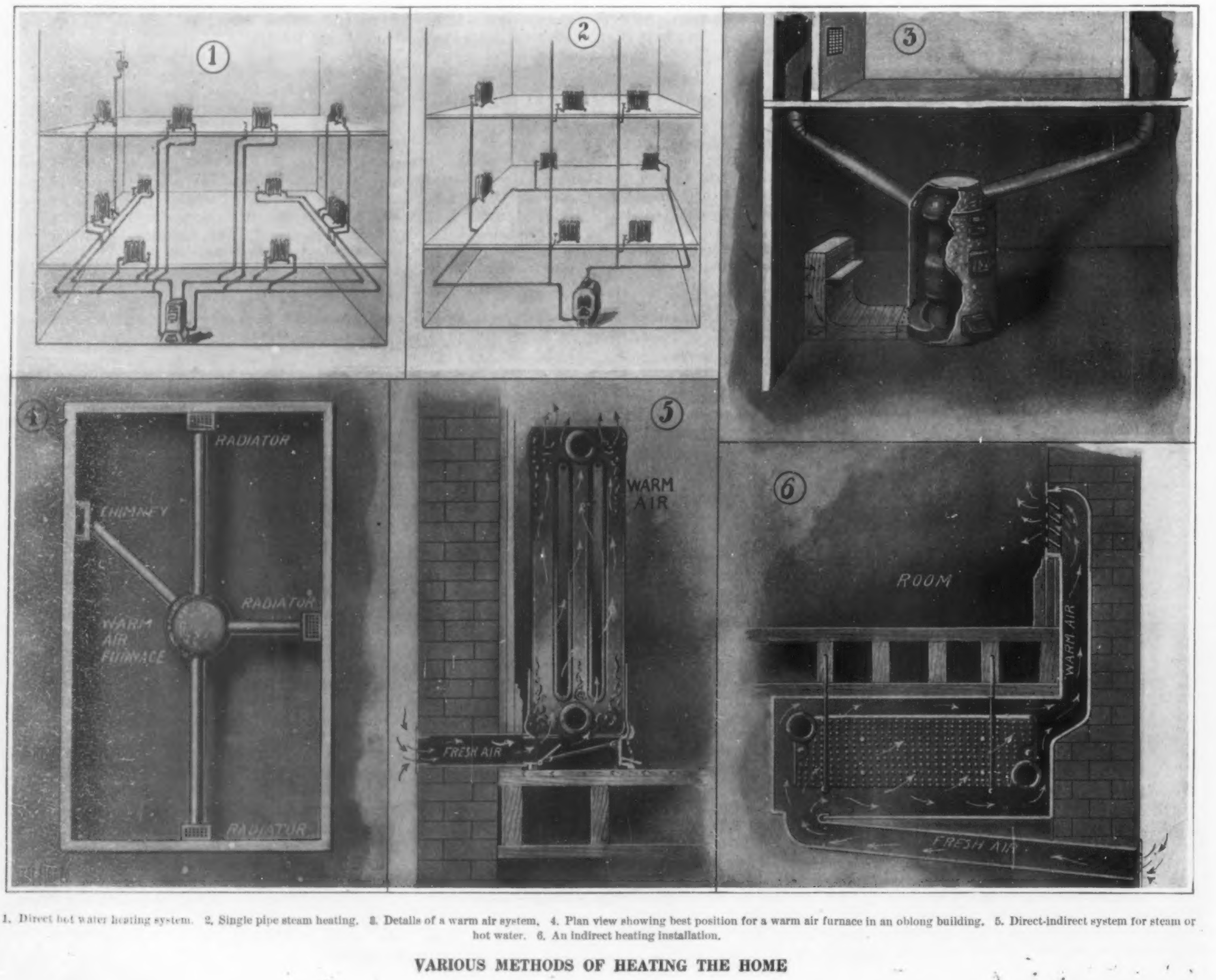
The state of air after it has once been breathed has parted with about one-sixth of its oxygen and taken up an equivalent of carbonic acid gas. This same air breathed successively a few times would part with all its oxygen and could no longer sustain life. The impure air containing carbonic acid gas, expelled from the lungs, is rarified by warmth and temporarily rises, but upon cooling it descends and lies in greatest density near the floor. Contact with the hot radiators causes this carbonic gas laden air to rise as it is again rarified by the heat. The lack of adequate ventilation causes the same poisoned air to be breathed over and over, producing the drowsiness and stuffy feeling complained of.

Breathing is a form of combustion. In burning of coal, wood, candles, gas, oil, etc., similar action takes place. Steam, hot water, warm air, and electric heating systems do not in any way affect the air with the exception of making it more dry, rarefied, or expanded. The radiators are distributors of heat, but do not use oxygen or in any way change the elements of the air, as the heat is generated in the furnace and a proper air supply is provided.

Then the vital importance of proper ventilation is manifest, and it may be most readily and economically provided for in connection with any of the modern heating systems. If a new house is planned, ventilation should be arranged for, together with the heating system. Old houses heated either by stoves, direct steam or warm air should be provided with some adjustable ventilation, particularly if fitted with storm windows, or if the windows and doors are well weather stripped and fit tight. Some windows can easily be fitted with a ventilator and good results be secured.

In selecting a heating system, a little time given to consideration of general conditions will avoid ex-

(Continued on page 389.)



1. Direct hot water heating system. 2. Single pipe steam heating. 3. Details of a warm air system. 4. Plan view showing best position for a warm air furnace in an oblong building. 5. Direct-indirect system for steam or hot water. 6. An indirect heating installation.

VARIOUS METHODS OF HEATING THE HOME

Lamps of To-day

Some Recent Improvements in Artificial Light Sources

By Joseph B. Baker

"MORE light" is the word of this twentieth century of intensified life, the universal demand in home, office and factory, and this demand is being met by the inventive talent and manufacturing enterprise of to-day. The active emulation now existing between the various light sources, beginning with the invention of the incandescent electric lamp and its formidable competitor, the incandescent gas mantle, has resulted to date in a number of different lighting systems utilizing electricity and gas, and it is the purpose of this article to discuss some of the more recent lamps which have been put into actual commercial use.

Efforts to produce a light of true color value by means of the electric arc have resulted in the "intensified arc lamp," which is a modified form of the well-known inclosed arc, based on the demonstrated principle that the light-giving efficiency of an electric arc is inversely proportional (within limits) to the diameter of the carbons; for example, 500 watts put into a quarter-inch carbon gives almost double as much light as with a half-inch carbon. In the intensified arc lamp there are two positive carbons of very small diameter (six millimeters, as compared with the ordinary single fifteen-millimeter positive carbon) and one negative carbon, also of small diameter. The current density at the carbon tips is extraordinarily high, resulting in a far higher degree of incandescence than in the ordinary lamp, so that the white light emitted from the carbon tips is a much greater percentage of the total light emission. For color matching the light of this lamp equals the best results attained by other means.

In flaming and luminous arc lamps the light is emitted from the arc itself, there being very little radiation from the electrodes, and the luminous efficiency is three to five times that of the best pure carbon arcs. As far back as June, 1906, there were at least ten different makes of flaming arc lamps in Europe. Among these were the Bremer, the Siemens, and the Koerting and Mathiesen; but at the present time their name is legion. The recent improvements are very largely based on the work of Bremer, in 1898. A distinction must be drawn between the flame arc lamp, in which the electrodes are of cored carbon, the core being impregnated with light-enriching metallic salts, and the so-called luminous arc lamp, in which the electrodes are entirely metallic, with no carbon. Typical examples of this kind are the magnetite lamp of the General Electric Company and the Westinghouse metallic flame lamp.

Flame lamps with carbons impregnated with calcium and sodium carbonate give a yellow or yellowish-golden light, and impregnation with strontium and rubidium salts gives a reddish pink light. The color of most flame lamps in common use to-day is yellowish, as it has been found that the yellow light-giving salts are by far the most efficient. Flame lamps giving a white light are also used to some extent, but the barium salts employed have a light-giving efficiency equal to only about half that of the yellow light-giving salts.

In flame lamps the recent developments have been in two directions: Longer life and higher luminous efficiency. In one new lamp a small inclosing globe conserves the life of the carbons and at the same time secures a better distribution of the illumination. The products of combustion are for the most part carried upward and condensed on the upper surface of the inclosing globe where they cannot interfere with the light. In another form, the hot gases are continuously circulated through the inclosing globe by an induced draft set up in a pair of curved tubes connecting the top and bottom of the globe; the gases, laden with volatilized metallic salts, pass out at the top only to re-enter at the bottom and so give a regenerating effect. In this lamp not only is the luminous efficiency increased, but the life of the carbons is conserved to a remarkable degree—a pair of carbons lasting seventy-five hours or more, or five times as long as in the absence of the regenerative feature.

The magnetite lamp gives a high efficiency, and has the added advantage that the magnetite electrode consumes at an extremely slow rate, a stick five inches long lasting 175 hours (corresponding to at least two weeks for an all-night street lamp).

Very important improvements have recently been made in two well-known vacuum-tube lights, the Cooper-Hewitt and the MacFarlan Moore, making available on a commercial basis the advantages already possessed by these systems—long life and high luminous efficiency—and giving a decided impulse to their wide practical application.

The light-transforming reflector for use with the Cooper-Hewitt lamp, which has already been described at length in these columns (see page 502 of SCIENTIFIC AMERICAN for December 24th, 1910) is an absolutely unique solution of the problem of obtaining illumination of satisfactory quality or color value from a light source having an ill-balanced spectrum. Briefly, this invention consists in utilizing the little understood phenomenon of fluorescence to transform the radiation of a given light source from one set or range of wave lengths into another entirely different set. As applied to the well-known mercury-vapor tube, a concave, trough-like reflecting surface, coated with a translucent film impregnated with rhodamine dye, receives the light of the tube and gives it back in altered form, the greenish light becoming converted into rays of wave lengths lying in the red and orange region of the spectrum, so that the lamp equipped with such a reflector gives an illumination similar to "daylight." Although the light-transforming reflector has not yet been developed for general commercial use, it is to be expected that it will render widely available not only the mercury vapor tube, but other light sources, which although highly economical are at present unsuitable for general illumination purposes.

The MacFarlan Moore white-light window is the culmination of twenty years of patient labor by its inventor, in pursuit of an ideal. In 1891 Mr. Moore, impressed by the unsatisfactory color of existing incandescent lamps and with the absurdly low efficiency of transformation of heat energy into light by all methods, was fired with the ambition to produce by electrical means a light source which would reproduce daylight. At the outset he was convinced that luminous radiations could be produced by a less wasteful method than as a mere by-product of heat, and that no department of physical science offered more inspiring opportunities than that of generating "light without heat." Moreover, the utilization of a gas as the working medium held out the promise of being able to take advantage of the selective vibration of gases. He therefore turned away entirely from the notion of a heated filament of solid resistance material for the conversion of electrical energy into light, and began investigations, using a column of rarefied gas. The result has been the Moore tube light, of which the light window is the most recent development.

The light window is virtually a portable box of artificial daylight, giving in effect a generous north window open to the unclouded sky of summer, available at any time by simply turning on a switch, and giving a true and unchanging illumination throughout the entire twenty-four hours of the day if desired. It consists of a metal case containing a length of the Moore light tube (a 1¾-inch clear glass vacuum tube, filled with highly rarefied carbon dioxide gas and traversed by an alternating current) and giving a pure white light of about 200 candle-power, but of remarkably soft illuminating efficiency. The ordinary outfit is equipped with a tube adapted to 220-volt, 60-cycle alternating current. A simple "breathing" device, operating about once every minute with remarkable regularity as long as the circuit to the tube is closed, keeps the contained gas in the right condition for most efficient generation of light.

The light window is singularly well adapted to fill a great existing need. One notable application is in the department store, where at present the purchaser of a piece of goods will often ask the salesman to carry it to the entrance of the store in order that

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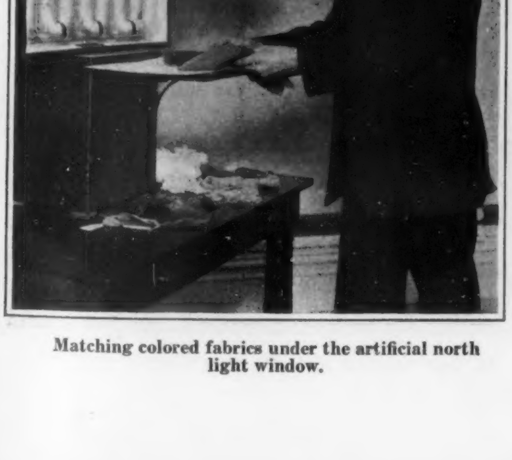
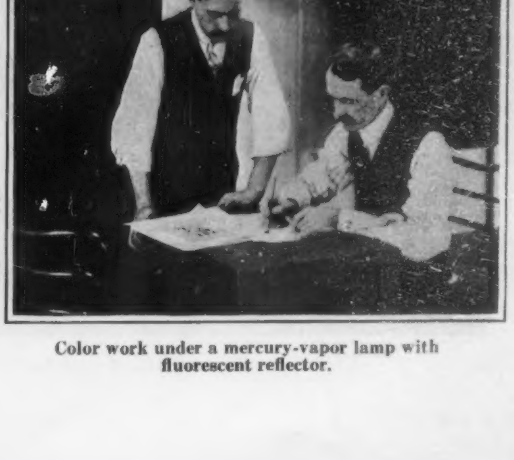


Matching colored fabrics under the artificial north light window.

Incandescent mantle lamp burning denatured alcohol.



Color work under a mercury-vapor lamp with fluorescent reflector.

SOME INTERESTING LAMPS OF TO-DAY

Light and Power on the Farm

Independent Electric Generating Plants

By Putnam A. Bates

THE prevailing impression of a farmer's life is one of toil under trying conditions. This view of things is not a cheerful one, but too often it is well grounded. The pleasure of active life in the country is greatly lessened by the inconvenience of things and under such handicap the accomplishments of the farmer do not compare favorably with those of men engaged in other pursuits. This state of affairs, of course, is not universal and can be rectified by the introduction of efficient methods of arriving at results. Theorizing, however, is an easy task and improvements based on radical reforms seldom reach the desired goal.

Before prescribing methods of improvements for the farmer, one should place himself in the yoke for a while, in order to know what the conditions really are. A short experience will prompt greater respect for the subject of our consideration, for farming is a many-sided problem, and one must be blessed with unusual poise to succeed in such a field.

It is also essential that whatever recommendations one would venture for the farmer's improvement should be of such character as to permit of practical application to certain definite conditions. Otherwise, the ideas, good in themselves, will mislead or be rejected as impractical.

A brief study of what farming really is, and how it compares, from a business point of view, with other industries is all important, for there are innumerable branches in which one may specialize in farming, as in other industries, and we find a wide range in the quantity and quality of the products turned out by various farms, even in an agricultural section of limited range. How important, therefore, it is that we define the kind of farming problem we are trying to improve before we state the means by which the results are to be obtained.

A man will embark in manufacturing because he sees an opportunity to succeed in life by doing so. He will prepare himself for a professional career, and after due qualification he will apply himself to his line as a life's work. Yet of agriculture we are continually hearing the question raised, "Is it possible to make a farm pay?" We may as well ask, will a factory pay, or can a lawyer make a living at his profession? I have been told that the remuneration of the average lawyer is just about that of the average school teacher, which fact is, I think, a fair answer to the latter question, and illustrates that it rests with the individual to succeed or fail.

Naturally, a farmer cannot run a large farming proposition on a narrow gage basis and make much of it, nor is it feasible to equip a small farm with all the possible conveniences and labor saving devices, if the total possible product will represent only an income return on a small investment.

There is, therefore, no sound reason for regarding farming business as different from any other, in so far as net results are concerned, the object of all business being to provide a living and enough more to be on the safe side in case of possible reverses. If one cannot see such an opportunity in farming, efforts should be directed elsewhere.

There is a peculiarly romantic side to country life that seems to lead persons wholly unqualified for any business to believe they will succeed at farming. This, of course, is unfortunate and accounts for many failures, but the reason for it is easily explained.

In manufacturing, an industry is appraised on the basis of the intrinsic value of the factory and general plant equipment, its suitability for turning out the product in greater or lesser quantities than competitors, and at greater or lesser cost. If property and buildings are appropriate, but capital is insufficient to properly equip, then capital is obtained by bonded debt or other approved method, and the funds are applied for this purpose and machinery is selected, with a view to obtaining the greatest returns for a given sum of money invested.

Successful farming must be developed on a similar basis, for the agriculturist is a producer, and his problem is little different from that of the manufacturer. His materials and operations are different, but that is all.

How often do we see farmers struggling through life with vastly more land than they can successfully manage with their degree of business ability, with a mortgage obtained to send the sons and daughters to school or college, the buildings entirely unsuitable in both design and location for economic operation, a mechanical equipment that suggests methods of fifty years ago, and practically no labor, except possibly one or two indifferent individuals who are not overblessed with intelligence.

What is the reason for such a condition? It surely is not that the farming business does not offer opportunity for success, for we have many examples of the foundation of large fortunes being laid by successful farmers. Yet such cases occur because it is easy to forget that a farmer's acreage and his buildings and equipment represent his capital. If he does not utilize them to the fullest, or if at the outset they are poorly adapted to his purpose, failure will result. Every acre of his property has a producing value, and this largely governs the worth of the entire property. The land may have been inherited or it may have been purchased. Its value to the farmer, however, is based on its capability to produce, or, to be more exact, upon his ability to make it produce.

In a manufacturing business, it is expected that capital will be turned over one or more times a year producing gross profits of 5 to 10 per cent on each turn over, and in farming, we should expect the same. A 500-acre farm, valued at $100 an acre, represents $50,000 capital. To turn this over once means that each acre must produce a total crop having a market value of $100. This result is possible, and where farming is successful, such return is not unusual.

These ideas seem like simple truths, but they are conditions that must be recognized. How much better is it for the farm mortgage to be applied in improving the operating conditions, buildings and equipment which will at once create a new interest for the members of the younger generation, and lessen the labors of the farmer himself, and put the proposition on a basis similar to that found in manufacturing, the Scotch spinning mills, for example, where the business passes from father to son, each one making his success in turn. This, however, cannot be done without the constant introduction of those improvements which are demanded by competition.

The erection of more suitable buildings, better located and planned for greater convenience, is a usual need on the farm. Provision for sanitation, with respect to the water supply and sewage systems is also a matter of importance.

It is safe to conclude, however, that success in farming especially requires good management, and due to its manifold applications, electricity is proving to be the force in nature most capable of assisting in the accomplishment of

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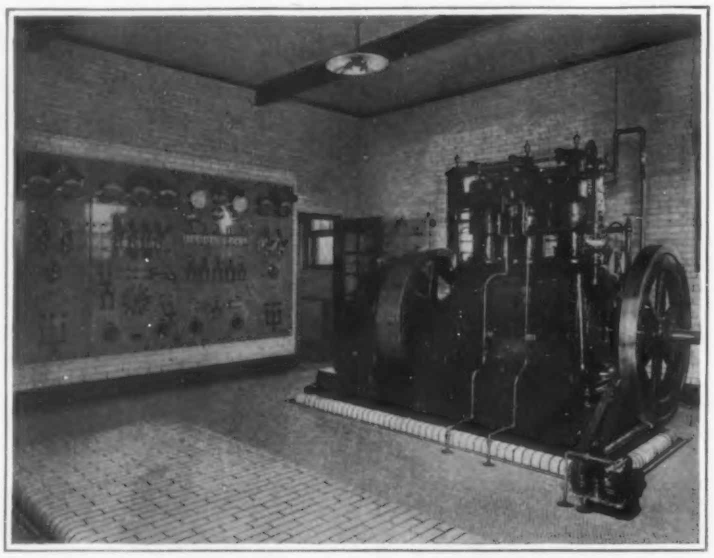


Fig. 1.—A high-powered equipment for a large farm.

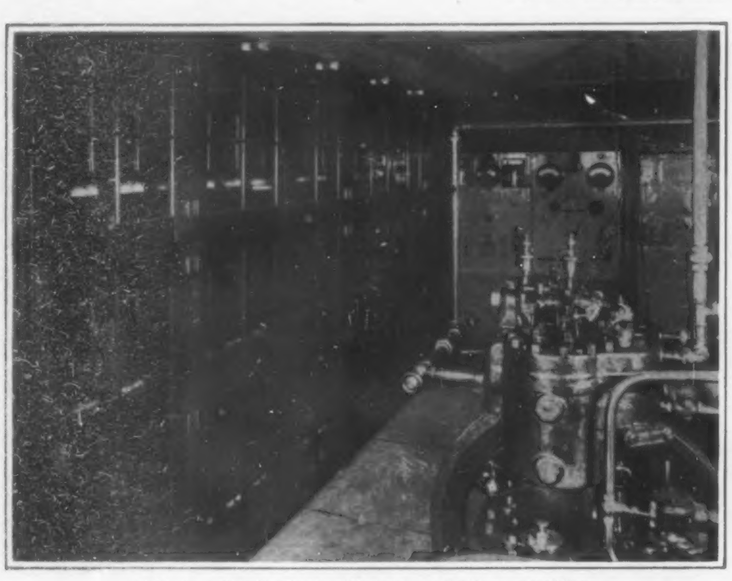


Fig. 2.—Small plant with storage battery auxiliary.

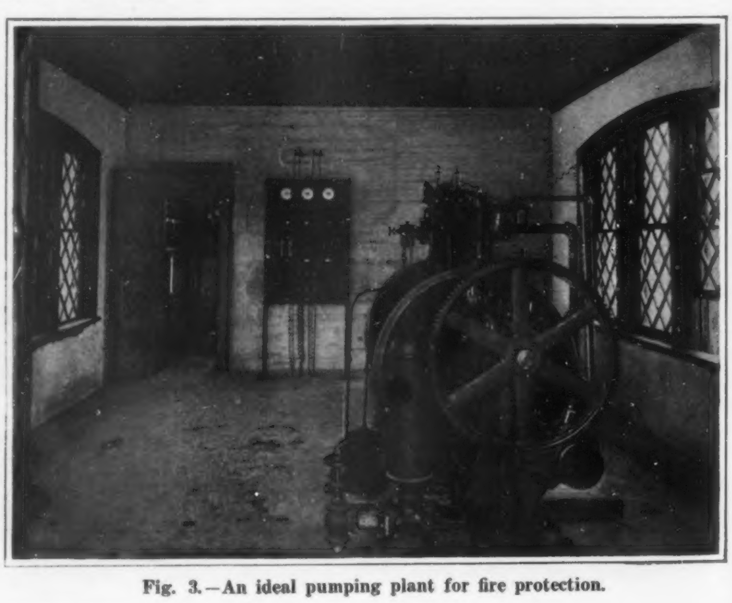
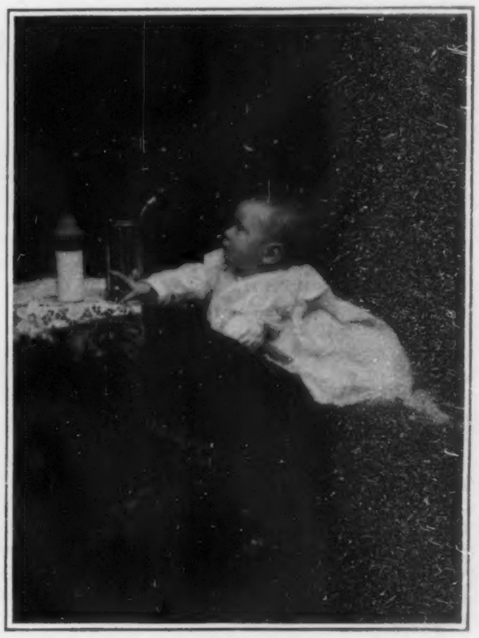


Fig. 3.—An ideal pumping plant for fire protection.

INDEPENDENT ELECTRIC GENERATING PLANTS

Putting off bedtime.

In the soft glow of the electric heater.

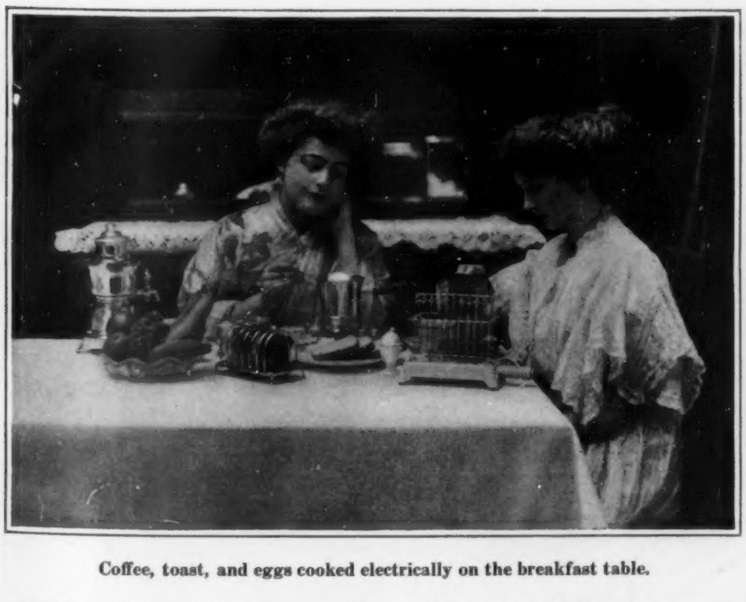


The nursery bottle heater is appreciated.

Simple cooking with an electric chafing dish.

Electric heaters, sterilizers, and hot water bags are invaluable in the sick room.

The electric iron is ideal for hot weather.



Coffee, toast, and eggs cooked electrically on the breakfast table.

Shaving in comfort with electric light and heat.

One of the most serious obstacles to the introduction of electric heating devices in the home has been a popular impression that the cost of operating them is too high for any but the rich. When it comes to be understood that electric heating is cheaper than any other form of heating when used on a small scale, the electrical invasion of the home will be complete. All of the devices shown above are most economical in their use of electricity, and will add but little to the bill for current at the end of the month.

ELECTRICAL INVASION OF THE HOME

Inventing the Light of the Future

The Eye as the Ultimate Judge

CONSIDER the devious method of producing light in the bulb of an incandescent lamp. Coal must be shoveled into a furnace to heat a boiler. Steam must be generated and fed to a steam engine. The steam engine drives a dynamo. The current generated by the dynamo is conducted to its destination by wires and at last reaches the filament in the little glass bulb.

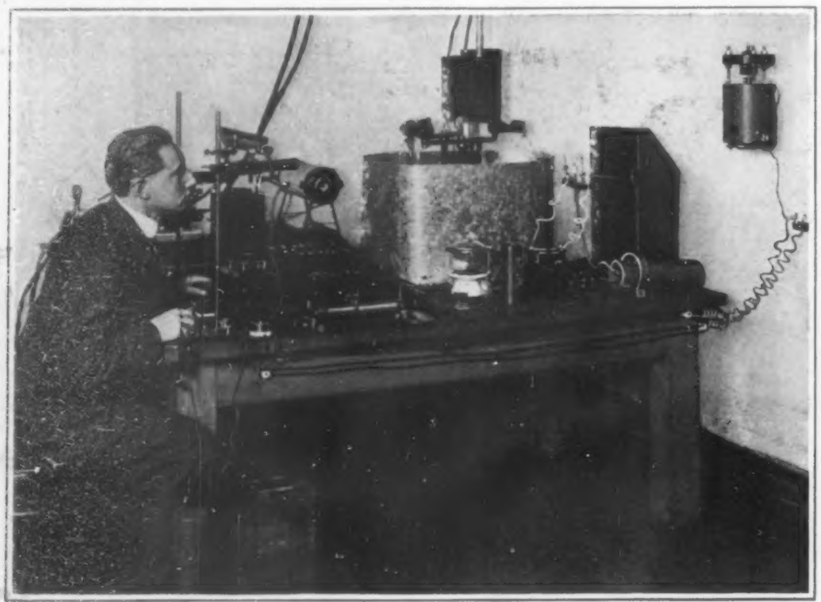
In producing the most efficient artificial light known only about five per cent of the energy in the coal pile is used in the form of visible radiation. The remaining ninety-five per cent is wasted chiefly by the steam engine and in producing heat rays that are not visible.

Consider now, the fire-fly, a creature which you can hold in your hand and feel no heat and which glows intermittently at will. Studies made many years ago by Dr. Samuel P. Langley and repeated more recently and more elaborately by Drs. Ives and Coblentz, show that the fire-fly's efficiency is about 96.5 per cent—that its light is well-nigh cold. What more striking illustration of the wastefulness of man and the economy of nature can be desired?

It is partly because the eye must be considered first and last that the problem of inventing a really efficient light is so very difficult. Then, too, there is the difficulty that light is not a physical quantity like gravitation or electricity, but rather the effect upon the retina of certain kinds of radiations. Of all the radiations which are continuously bombarding the human body, only a few affect the eye. It so happens that the sun and all artificial lights are deluging us not only with radiations that we can see, but with a great many more that we cannot see. For example, there are those radiations which manifest themselves as heat, and again those which we know only by the way in which they affect photographic plates and chemicals sensitive to light. In the visible range of radiations, moreover, the amount of energy varies considerably. Thus, the visible radiations that we call green light represent an entirely different amount of energy and a much greater physiological effect than the same amount of energy in rays that we call red light. The problem is still further complicated by the fact that not only is the amount of radiation for any color different from that of any other color, but that the intensity, and consequently the effect upon the eye varies with every color. A green light and a red light at a certain distance appear of equal brilliancy to the eye, but reveal different intensities at greater distances. Then, again, the method by which a ray of light is able to stimulate the ending of the optic nerve in the retina so that we can see, is not yet understood.

The problem of producing an artificial light to compare favorably with that of the fire-fly involves research of a kind that can be undertaken only by a splendidly equipped laboratory supported by an almost princely endowment. A single physicist or chemist or engineer may possibly make important contributions to the solution of the problem; but the efficient light of the future, in all likelihood, will be the work not of a single man, but of many men, of generations of men, perhaps, who have conducted painstaking researches in the physics, chemistry, and physiology of light. The problems become so complex, so special in their nature, that only specialists can hope to deal with them.

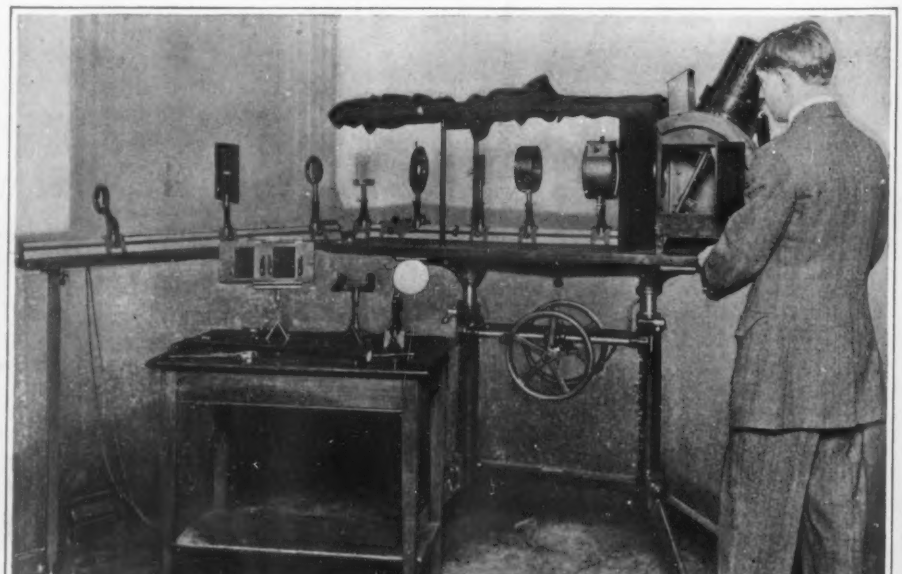
To improve the electric light, in quality, to find out how different lights affect the eye, to produce light with less waste of power, twenty manufacturing companies have established at Cleveland, Ohio, a remarkable group of laboratories, which, in point of equipment and in the nature of the studies there carried out, rank with the research and engineering labora-



An apparatus for studying the infra-red radiation of various artificial illuminants.

Measuring the amount of light given by a light and its reflector at all angles.

Phosphoroscope for studying the light effect of phosphorescent materials.



A Zeiss color-mixing apparatus for blending together radiations of various wave lengths for comparative tests.

TESTING APPARATUS FOR THE STUDY OF LIGHT

tories of the government and of richly-endowed institutions.

So difficult are the subjects to be studied that not only have these companies established laboratories for the purely commercial development of the electric lamp, but also a special physical laboratory at the head of which stands Dr. Edward P. Hyde, formerly of the United States Bureau of Standards, in which laboratory a vast amount of pure scientific research, quite devoid of any direct commercial use, is conducted, and which has for its specific purpose the proper co-ordination of physics and physiology.

How very essential is purely scientific research in the improvement of artificial illuminants is apparent when we consider the peculiar nature of light.

What we call light does not exist in the universe apart from eyes that see it. The light rays that physical science deals with are in themselves no more red or blue than the dark heat rays or than the X-rays. The sunshine has no splendor except to our retinas. By this we do not mean that the sun does not exist, but simply that the blue of the sky, the green of swaying trees and waving grass, are due simply to the magical property of a piece of living tissue, a tissue called the retina, and endowed with the miraculous power of transforming rays and undulations of a certain degree of rapidity into mental pictures of unspeakable beauty.

A German professor is reported to have said that, if a student of his were to submit to him an optical instrument so poorly constructed and so inefficient as the eye, he would probably "pluck him," on examination. But the eye is a good deal more than a lens, an aqueous humor, and a retina. It is a camera, a dark room, indeed a whole chemical laboratory; for here the most wonderful chemistry in the world is done. The eye takes the picture of nature, develops it, and presents it to your vision, all in one operation —far more than has ever been done with an instrument of human invention. Because we must reckon with a living organ in trying to improve light, because this remarkable complicated camera and laboratory was planned by nature to adapt itself to the requirements of sunlight only, because nature, perhaps, never contemplated the use of artificial illuminants by man, it is not easy to invent a light which will not only be cheap, but which will not play havoc in the end, with the delicate apparatus whereby we see.

Hence, to invent a highly efficient light, not only the engineer and physicist, but the physiologist and even the psychologist must each do his share.

Suppose, for example, that the engineer had really succeeded in producing a light in direct imitation of the fire-fly's. He would find, as Dr. Herbert Ives, a member of Dr. Hyde's staff, has conclusively shown by spectro-photography, that his artificial fire-fly, although very efficient in the consumption of energy, would be quite unsuited for general use. It is too green. If you have ever stood beneath a mercury arc and noticed the purplish veins that crawl over a ghastly green flesh, you can picture the effect of a thousand-candle fire-fly. Green is the most efficient light because the yellow-green portion of the spectrum is most intense. Curiously enough, the greenish mercury arc is one of the most efficient lights that man has produced. Hence, science and engineering have approved the fire-fly's choice of color in getting efficiency.

The physiologist would object to any slavish imitation of the fire-fly on the score that a yellow-green light, however efficient, would be injurious, and would distort color values. The physiologist would protest against the use of a greenish-yellow light of 96 per cent efficiency, and insist upon the employment of a certain amount of red rays. The most efficient white light of the future would be cut down by the physiologist to approximately 40 per cent of a yellowish-green light's efficiency.

So far as we can now foresee, high efficiency in the light of the future can be obtained by one of three possible ways or by a combination of these. One of them is to confine the radiation to the visible spectrum, as the fire-fly does, overcoming the objection cited by properly blending it with other colored radiations produced with equal efficiency.

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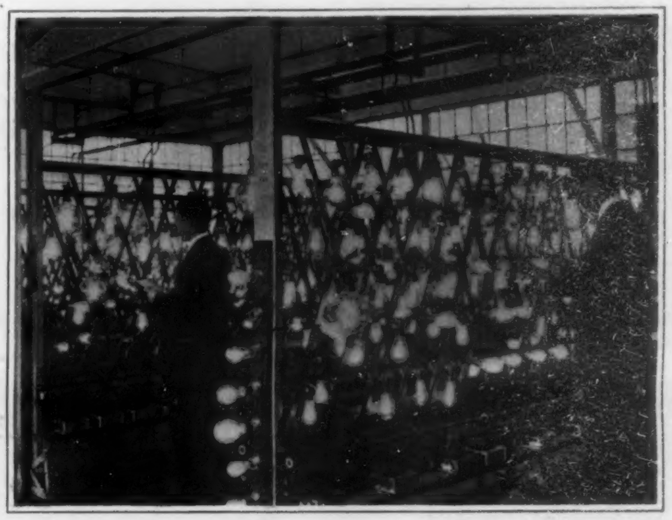
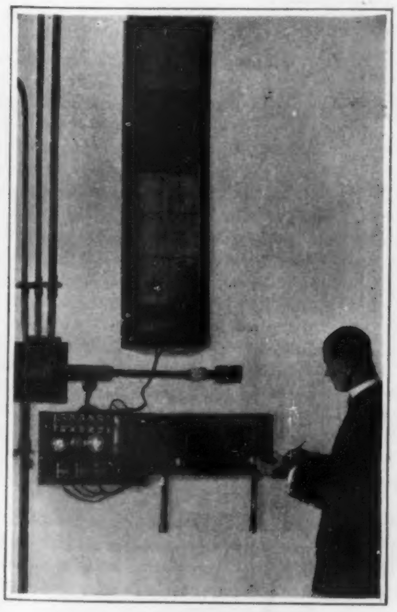
An instrument devised to analyze the effect of side illumination on the eye.



Where the life of new lamps is ascertained.

Calibrating instrument for regulating current supplied to life racks.



Counters for automatically registering the hours during which a lamp has burned.

Making microphotographs of filament cross-sections in order to study effect of current on structure.

A corner in the lamp-testing laboratory.

APPARATUS FOR STUDYING THE ELECTRIC LIGHT

Science in the Current Periodicals

In this Department the Reader will find Brief Abstracts of Interesting Articles Appearing in Contemporary Periodicals at Home and Abroad

Artificial Rain

IRRIGATION was practised extensively in ancient times in Egypt, Assyria, Persia, China, Japan and India. It was employed by the Moors in Spain and by the Romans in Italy, and the Spanish conquerors found great irrigation systems in existence in South America. In many of the lands, especially in China, the primitive and traditional method of irrigation is still in use, while in California, Texas, Northern Italy, Southern France and elsewhere, deserts have been converted into farms by systems of irrigation constructed on the principles of modern applied science.

An irrigation system consists essentially of a net work of canals and ditches which traverse the arid region and are supplied by pumps or by dams and reservoirs. The water either seeps through the walls of the ditches or is caused to overflow the land by damming the ditches. Irrigating systems are constructed for large districts and also for single farms and fields. In the latter case pipes are often substituted for ditches, and the pipes are sometimes connected with sprinkling apparatus by which the water is distributed over the land in the form of artificial rain. These devices are not very largely employed, owing to their great cost of construction and operation, their rapid deterioration under rough usage, and other defects.

A new apparatus, devised by Hartman, which has given good results in Germany, is described in a recent issue of *Prometheus*, from which the following account is taken:

The water is drawn from any convenient pond, stream or spring, and is pumped to the field through a portable system of pipes laid on the surface of the ground (Fig. 1). The power may be obtained from the traction engine (Fig. 2) with which every large farm should be provided. The sections of the water main (Fig. 1) are connected by very simple and quickly operated clamps, without screws, and the main is provided, at intervals of 66 feet, or 4 rods, with cut-off valves which can be connected to the sprinkling apparatus by short lengths of flexible hose. The main is adapted to the inequalities of the ground by the insertion of elbows wherever they are required. The artificial rain is produced by rotary sprinklers, resembling those commonly used on lawns, and turned by the reaction of the stream of water. The sprinkler has two opposite arms, each of which is 5 meters ($16\frac{1}{2}$ feet or 1 rod) long, and is perforated with a number of lateral orifices, while the terminal orifice projects a stream, radially, to a distance of one rod farther and a second terminal nozzle, which delivers a still more powerful stream, is automatically brought into operation four times in each revolution. The result is that the sprinkler waters an area four rods square. The sprinkler is connected to the middle of a horizontal pipe four rods long, which is mounted on a single wheel, the whole constituting a sprinkling carriage, or unit of the system. Similar carriages having pipes four rods long, without sprinklers, are used for connections.

A large field may be conveniently watered with the aid of four sprinkling carriages and two pipe carriages. A sprinkling carriage is connected by short flexible hose to a valve of the main, and a second sprinkling carriage is similarly connected to the first one. To the same valve, but on the opposite side of the main (the east side, for example) is attached a chain of two pipe carriages and two sprinkling carriages. When the plots covered by the sprinklers

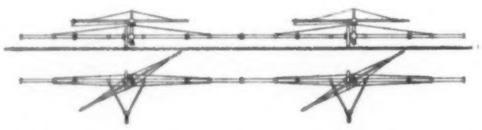


Fig. 3.—Elevation and plan of two coupled sprinkling carriages.

have been sufficiently watered, the six carriages are disconnected from the valve and drawn forward four rods to the next valve, by means of light cables and winches. By repeating these operations until the end of the main is reached, two strips of land, each eight rods wide, are watered. The main forms the eastern boundary of one water strip and is separated from the other by a dry strip eight rods wide, over which the non-sprinkling pipe carriages have traveled. All of the carriages are then placed on light-wheeled trucks and moved eight rods westward, retaining their relative positions. This maneuver shifts the eastern pair of sprinkling carriages to the dry strip just east of the main, the non-sprinkling pipe carriages to the watered strip west of the main, and the western pair of sprinkling carriages to the next eight-rod strip of the field. The sprinkling is then resumed and the line of carriages is drawn back, from valve to valve, until they reach the end of the field from which they started. The whole series of operations results in watering a belt 32 rods, or 528 feet, wide, and as long as the main, which occupies the median line of the watered belt. The main is then taken apart and shifted 32 rods westward, and the series of operations is repeated.

A system of parallel and conveniently spaced stationary pipes may sometimes be preferable to one portable main. The pipes should be so constructed that they can be moved easily, so that they can be used in different fields in different years, according to the crops planted.

As the wheels of the carriages are four rods apart and more than five feet in diameter, they do little damage to crops. The tracks made by the wheels occupy only about one per cent of the total surface.

The Hartmann system of irrigation by artificial rain is not very expensive. An apparatus capable of delivering 700 gallons per minute, and including pipe sufficient, when laid permanently, to supply 60 acres, costs less than \$4,000. The area served can be trebled or quadrupled by frequently shifting the pipes. With a flow of 700 gallons per minutes about 19 acres can be supplied with water equivalent to a rainfall of two-fifth inch, in a working day of ten hours. In general it may be estimated that an artificial rainfall of two-fifth inch costs about 50 cents per acre. The experiments already made show that this expense, which includes an allowance for amortization, is small in comparison with the increase in yield, which may exceed 100 per cent, even in seasons which are not exceedingly dry. The advantage derived from artificial rain in very dry years can scarcely be estimated.

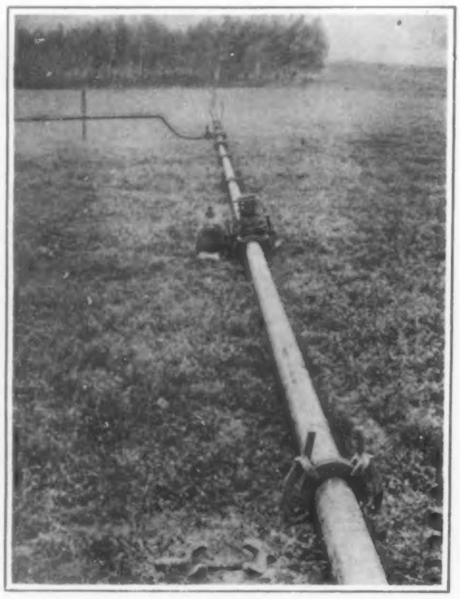


Fig. 1.—Portable main for production of artificial rain.

Fig. 2.—Traction engine.

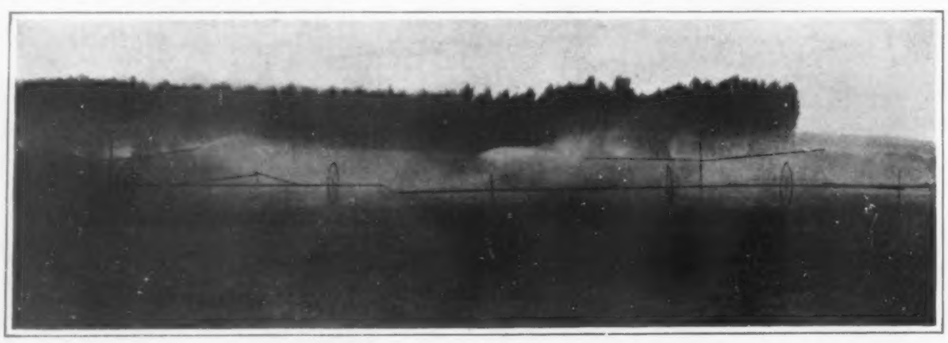


Fig. 4.—The line of sprinklers in operation.

MAKING RAIN WHEN IT IS DRY

The Resurrection Plant

THE Resurrection Plant, whose botanical name is the *Anastatica*, is sometimes called "The Rose of Jericho." No other plant has been credited with so many extraordinary qualities, and none has been of greater service to quacks and charlatans ever since its peculiarities were discovered.

It has been called "the resurrection plant" by reason of the fact, that when apparently dead and dry it often assumes again the color of life as soon as its root is plunged into water. Its buds swell with new life, the leaves of its calyx open, the petals unfold, the flower stalk grows, and the full-blown flowers appear as if by magic. It is not, strictly speaking, a rose at all; the stem divides at the base and bears spikes of pretty white flowers, which change into round fruits. When ripe the leaves fall, the branches grow hard and dry, and fold inward so as to form a ball.

In autumn the plant is uprooted by the storms and carried toward the sea. There it is gathered and exported to Europe, where it is highly prized for its hydrometric qualities.

All that is necessary is to place the end of its root in water, and soon the plant is seen to begin a new life, develop its parts and unfold new roses. When the water is removed, the spectator sees the magical plant grow weak; its petals close and the leaves pass through the last agonies of vegetable life and die.

The resurrection plant grows in the sandy regions of Egypt, Syria and Arabia, and has long been connected in popular superstition with the Holy Land and the life of Jesus. In certain countries it is still believed that this remarkable flower blooms every year on the day and at the hour of the birth of Christ, and pious pilgrims still report finding it at every spot where Mary and Joseph rested on their flight into Egypt.

The Inventor's Department

Simple Patent Law; Patent Office News; Inventions New and Interesting

Evolution of the Vacuum-jacketed Bottle

THE vacuum jacketed bottle, so essential in handling liquefied gases that boil at very low temperatures, and now so widely used by travelers and others, is a comparatively recent invention.

The discovery that a vacuum space will prevent the transmission of heat from one body to another undoubtedly was made by Dulong and Petit, but to Prof. Dewar belongs the credit of first making a practical use of this discovery. While investigating the physical properties of hydrogenium in 1873, he used the calorimeter shown in Fig. 1. It is not stated what material the inner vessel is made of, but it probably was of metal. This inner vessel was secured in an outer brass cylinder, and the air between the two vessels was thoroughly exhausted. Although this first vacuum jacketed vessel proved very efficient and satisfactory, still there is no record of any attempt being made to make further practical use of it until in 1887, when M. d'Arsonval, in France, used a vacuum jacketed vessel, apparently very similar to the one shown in Fig. 1, to store liquid air, and published an account of his work. It is probable that M. d'Arsonval was not aware of Dewar's calorimeter vessel, and was an independent inventor of the vessel.

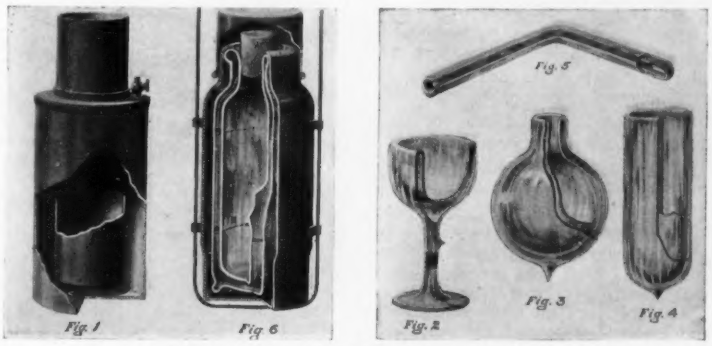
This metallic vessel, while quite efficient for storing liquefied gases, was ill adapted for studying the properties of the liquids themselves. By 1893, many of the so-called permanent gases were being liquefied in considerable quantities, and scientists were sorely in need of a better vessel in order to properly carry forward their researches in low temperatures. Dewar, to whom the scientific world owes so much, undertook the problem of devising a new vessel. He improved the calorimeter vessel of 1873, by making it entirely of glass. These new vessels which came to be known as "Dewar flasks" have many different forms, but the same principle is used in all of them, that is, they are made double, the inner vessel being united to the outer by fusing their necks together and the air between the two vessels is thoroughly exhausted. The forms of vessel most frequently used are those shown in Figs. 2, 3, and 4. The vacuum jacketed siphon tube (Fig. 5) is used for transferring liquid hydrogen from one vessel to another. If liquid hydrogen, which boils at —252 deg. C. or —421 deg. F., should be poured from one vessel to another, contact with the air would cause about nine-tenths of it to evaporate. To Prof. Dewar also belongs the credit for discovering that by silvering the facing surfaces of the vacuum space before exhausting and sealing, the efficiency of the vessel was increased six-fold. It is hard to overestimate the importance of these flasks, for they are just as essential in low temperature researches as the regenerative cooler of Siemens and Linde.

These vacuum jacketed vessels of Dewar, so simple and yet so wonderfully efficient, were generally considered to be too fragile for ordinary every-day use. When such a vessel was turned on the side for pouring out the contents, the leverage on the neck was often great enough to cause the bottle to break. About 1904, Reinhold Burger, of Berlin, a manufacturer of glass laboratory apparatus, added to the glass vacuum jacketed vessel certain features that made it a great commercial success. He gave the vessel the characteristic bottle shape shown in Fig. 6, and added a metal protective casing and also placed small pads of asbestos board between the two walls to relieve the strain on the neck of the inner bottle. The courts in this country and in England have held that Burger's patents on this bottle were limited to the supporting pad feature, and that there was no invention in merely changing the shape of the bottle or in adding the protective metal casing.

Supports between the walls obviously make the bottle less fragile, but they decrease the efficiency of the vacuum jacket, for they form bridges, as it were, for the direct transmission of heat from one wall to the other. However, it was found that a fairly durable bottle could be made without using these supports, and, in the absence of any dominating patents, many manufacturers were soon found engaged in making these bottles.

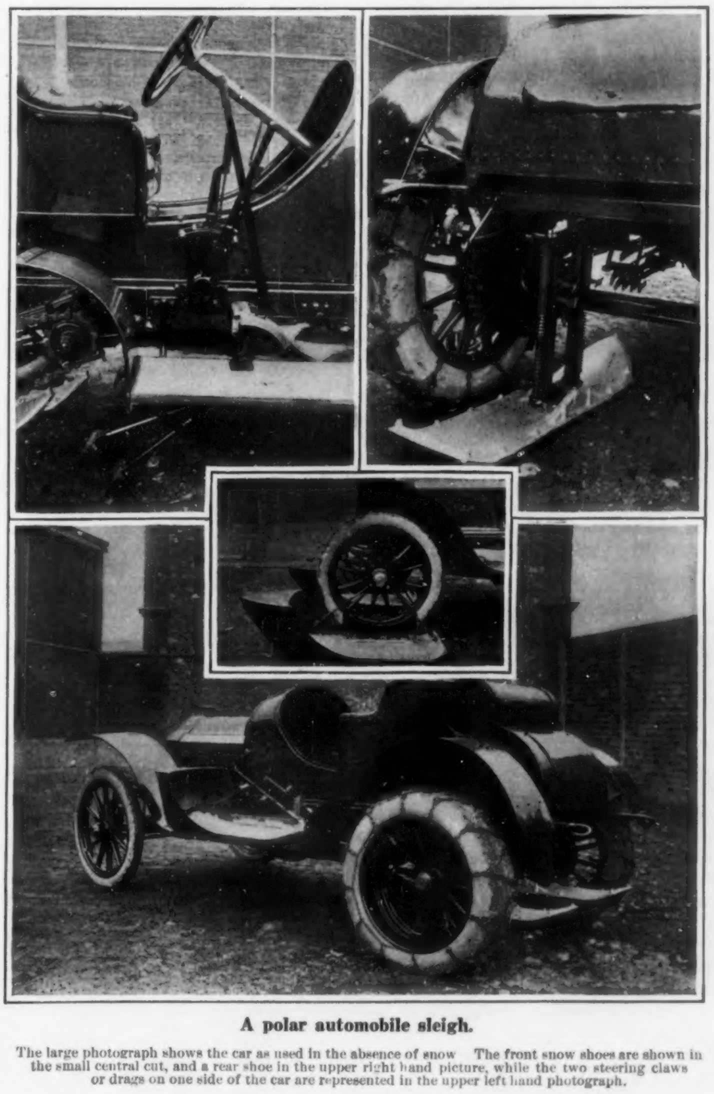
Many patents have been recently granted on improvements in the supporting devices and in the outer metal casing, but no substantial additions have been made to the work of Dewar and Burger.

For some unaccountable reason, these bottles deteriorate in time. Although they may be thoroughly exhausted at the beginning, there can be no doubt that air is present in the vacuum space after the bottle has been in use for a considerable period. It is practically certain that this does not leak in through the glass walls. The most plausible explanation yet advanced is, that it is air which was occluded on the surface of the glass, and this view is apparently substantiated by the conduct of X-ray tubes. By heating the glass during exhaustion, the durability of the vacuum is greatly improved. However, to future inventors remains the problem of finding a way for removing all the residue. When this is accomplished, we will have probably the most perfect heat insulated vessel that it is possible to make.



Different forms of vacuum-jacketed vessels.

1. Dewar's original vacuum calorimeter, 1873. 2, 3, 4. Common forms of "Dewar flasks." 5. Vacuum jacketed syphon.



A polar automobile sleigh.

The large photograph shows the car as used in the absence of snow. The front snow shoes are shown in the small central cut, and a rear shoe in the upper right hand picture, while the two steering claws or drags on one side of the car are represented in the upper left hand photograph.

A Polar Type of Automobile Sleigh

A NEW type of automobile has been constructed by a French maker who calls the vehicle a "Polar automobile sleigh." The accompanying photographs show the peculiar features which should make the car very useful for winter touring, if not for Arctic exploration. The large photograph gives a view of the vehicle when it is ready for use on roads not buried in snow. In appearance and in construction it does not differ essentially from an ordinary racing car. For traveling in deep snow a shoe or skate is placed under each of the front wheels and clamped firmly to the wheel in the manner illustrated by the small central photograph, and two other shoes are lowered on their double telescopic supports which embrace the rear axle, just inside of the wheels. The rear shoes are lowered until, by pressing on the snow, they support almost the entire weight of the after part of the car. The rear wheels are thus prevented from sinking deeply into the snow, but they graze its surface and penetrate sufficiently to continue to perform their function as driving wheels, as the chains with which they are wrapped act on the snow much as the paddles of a side-wheel steamer act on the water. The rear shoes are much longer and wider than the front shoes, pointed at both ends, and turned up slightly in front and sharply behind. The short front shoes have sharp, high and decked prows which enable them to act as snow plows, while their rear ends are square and curved slightly upward. On each side of the car, a little in front of the rear wheels, is a pair of forks or claws, which can be raised or lowered by means of a lever, as is shown in the upper left-hand photograph. Each pair can be operated independently. When both pairs are depressed they act as brakes, while steering is greatly facilitated by depressing the claws on one side only. When the front shoes are not in use they are carried on the foot boards, as is shown in the large photograph.

Proposed Abrogation of the German-American Patent Treaty

IN a cablegram from abroad, it is intimated that the German Machine Manufacturers' Association has petitioned the imperial government in an effort to deprive Americans of the benefit of the treaty with Germany and seeking to secure a new law regulating patents. The burden of the complaint appears to be that the Americans have an advantage in that they are not required to manufacture in Germany while the Germans are. Now, if we consider but a moment, we will recall that there is a true reciprocity. The German is not required by the United States patent laws to manufacture in the United States. Therefore, the German government in waiving the requirement of manufacture by Americans, only extends to Americans the same privilege in Germany that America extends to Germans in America.

In this view of the case, the complaint

does not seem well grounded. The treaty in question securing the rights to Americans in Germany corresponding to those enjoyed by Germans in America was fully considered by the lower house in Germany when it was up for approval by the Reichstag, at which time the then Minister of the Interior and now Imperial Chancellor of Germany, Von Bethman-Hollweg, advocated the treaty which was subsequently ratified by the imperial government.

In his report to Congress for 1910, Mr. Commissioner Moore says this "treaty was entered into with the German empire, which, in its broad workings, had the effect of not only protecting the American inventor, but the German inventor as well. That treaty has been construed by the imperial court sitting at Leipzig, and its provisions were upheld in some of the patents which had been declared forfeited, and they were ordered to be restored by the German Patent Office."

The decision referred to in the Commissioner's report is the one in which the National Cash Register Company was a party and by which the patents were saved to the company. A transfer of the patent was suggested by the plaintiff to the proceeding, and the court said, "The objection of the plaintiff to the taking over of the proceedings by the American company is therefore not to be considered, and said company being now alone authorized to defend the patents, must be admitted as principal party to the proceedings." The decision also says, "It therefore follows from the agreement that the compulsory working provided for in the German statutes can find no application when the patent belongs to a citizen of the United States. Since his own country does not provide for compulsory working, he is, by virtue of his nationality, to be exempt from it also in Germany."

The cablegram asserts that a representative of the government told the committee of the Reichstag that the passage of the new measure before the Washington conference in May was regarded as absolutely necessary. Apart from the power of the Reichstag to enact the legislation desired, it is by no means likely that an agreement solemnly entered into only little more than two years ago, and which was warmly advocated by the present Imperial Chancellor of Germany, will be seriously affected by any adverse legislation at this time. In any event, the agreement cannot be abrogated before the May Congress convenes, as Article 2 of the agreement of 1909 provides that such agreement shall remain in force until the expiration of twelve months following the notice of termination given by one of the contracting parties.

Notes for Inventors

A Prize for a Horseshoe.—The American Society for the Prevention of Cruelty to Animals has instituted a competition, offering, through one of its members, a prize of five hundred dollars ($500.00) for the best horseshoe or device designed to prevent horses from slipping on paved streets; the conditions, which constitute an agreement between the donor of the prize, acting through the Society, and each competitor who makes a submission under its provisions, being as follows: The competition is open to all without restriction; the right to reject any or all submissions is reserved by the Society, and the award will be made by the Board of Managers of the Society.

The improvement may be submitted either by drawings, or a model, or both. A description should accompany each application, stating, in detail, the merits claimed for the invention, the material used, or proposed to be used, in its construction, and its estimated cost; whether or not the invention is in actual use or has been tested, and the results as to wearing qualities, non-slipping qualities, and other advantages. Such descriptive matter should be typewritten although this is not compulsory.

Each sheet of drawing and each model and all descriptive matter must be unsigned, but must bear a device, cipher or emblem for identification; and the same device, cipher or emblem must be placed on a sealed envelope containing the competitor's name and address, which envelope will not be opened until the award has been made.

Drawings and models, with the accompanying envelopes, must be securely packed or wrapped and delivered at the office of the A. S. P. C. A., Madison Avenue and Twenty-sixth Street, New York, before 6 o'clock P. M. on Thursday, June 1st, 1911.

In making the award, the cost of the device, its wearing qualities, and all other points of merit, will be taken into consideration in addition to its non-slipping qualities.

The competition is in charge of a committee of which Henry Bergh, 50 Madison Avenue, New York city, is chairman.

Standardizing Post Office Equipment.—The Postmaster-General by order dated January 4th, 1911, and amended February 6th, 1911, has appointed a commission to consider the standardizing of post office furniture and equipment and to prepare drawings and specifications of such furniture and equipment as may be found feasible to standardize and to submit the same to the Secretary of the Treasury and the Postmaster-General, with appropriate recommendations.

The commission includes Charles F. Trotter, assistant superintendent Division of Salaries and Allowances, Post Office Department; William H. Haycock, superintendent of Delivery, Post Office, Washington, D. C.; George A. Gasman, assistant superintendent mails, Post Office, Chicago, Ill., and William E. Block, Postal Savings System, Post Office Department, Washington, D. C.

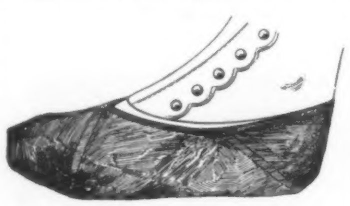
Inventors and manufacturers of appliances for use in post offices should appreciate a rather unusual opportunity, and those having improved devices either in the way of furniture or equipment, the latter being quite comprehensive, may be able to patent such improvements and be in a way to secure a practically unlimited market, if able to secure adoption of the improvements by the department.

Patenting a Skeleton.—An interesting patent (983,547) was recently granted to a resident (Charles E. Fleck) of Orange, New Jersey, for an anatomical skeleton, which is described as specially useful in connection with instruction and demonstration in the study and practice of osteopathy. The invention is defined in part as an anatomical skeleton composed of a number of elements and comprising a spinal column composed of a number of bones and means adapted to connect elastically the various elements and bones together, which is quite descriptive of the supporting framework we are all carrying around with us. The patent describes the invention as relating more particularly to improved methods of articulating the several bones in such a manner as to simulate closely the joining together of the bones in the living body. This patent emphasizes the important lessons that mechanics and inventors can learn from the study of the habits and operation of various insects and animals. It has been said that the special construction of the water main having universally jointed sections and by which water was conducted below the river Clyde, was suggested to Watt by the peculiar construction of the tail of a lobster. Also that Brunel conceived the process he followed in tunneling under the Thames from observing the manner in which the teredo bored its way through wood, and many other instances of the kind might be noted.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

DUST-MOCCASIN.—SARA E. WILTSE, West Roxbury, Mass., and HENRY M. WILTSE, 12 McConnell Block, Chattanooga, Tenn. The invention shown in the accompanying illustration has reference to moccasins, the more particular purpose being to produce a moccasin suitable for children, and adapted to be worn over



DUST-MOCCASIN.

the shoes in carriages or cars, for the protection of the clothing of the other people from mud or dirt often found upon the shoes of children. The invention further comprehends a neat form of moccasin easily and cheaply constructed and having a suitable form to be quickly put on or taken off and easily carried in the pocket or the shopping bag.

Of Interest to Farmers.

STRAINER.—T. H. DILGER, and L. L. DILGER, Lamar, Ind. This strainer is for use in straining milk directly as the milk is milked from the cow and thus preventing foreign matter, such as dandruff, hair, dust, etc., from entering the milk can, the strainer being provided with a waste pipe, through which the foreign matter and milk foam are discharged during milking. No opportunity is afforded for foreign particles dissolving or softening, when they would not be removed by a strainer, as in the case when the milk is strained at a later period.

MILK TESTING BOTTLE.—H. C. TROY, Ithaca, N. Y. The bottle allows free escape of the heated air incident to the mixing of the milk with the testing acid, thus preventing rising of the coagulated milk during the mixing operation, arranged to wash the fat free from sediment, by permitting the addition of water after the first whirling action of the centrifuge, and arranged to prevent distribution of sediment on the bottom of the bottle to prevent clogging of the graduated neck on emptying the bottle, and to permit its quick emptying.

Of General Interest.

HOLDER FOR UMBRELLAS, ETC.—HENRY C. ENGELBERG, care of North German Lloyd, 5 Broadway, N. Y. In carrying out the invention shown in the engraving the holder is constructed with two opposed jaws which are pivoted and preferably connected together to move in unison. Underneath the jaws is provided a chute flaring downwardly so that it

HOLDER FOR UMBRELLAS, ETC.

will guide the staff of the umbrella or other stick directly between the jaws, irrespective of the careless manner in which the article is introduced. Preferably suspended from the holder is a hanger having a ring base hinged thereto and adapted to assume a horizontal position to be folded against the hanger, and a drip pan seated in the ring base.

AMALGAMATOR.—W. E. BUSBY, McAlester, Okla. This invention relates to improvements in amalgamators used in extracting amalgamable metals from their ores, with means to prevent material which will not pass through the screen from contacting with the amalgamating plates, and means for supporting and rotating the cylindrical structure in an inclined position so that material placed in the higher end thereof will gradually work down to and pass out of the lower end thereof.

SCALE.—J. O. GARMON, Tropico, Cal. The invention has in view a scale capable of being easily moved from place to place and in which the scale platform may be easily loaded and unloaded, and the platform rendered firm, if desired, during the loading and unloading operation. Further, to so arrange the weighing mechanism that no part will be located under the platform but in an accessible position for inspection, etc.

Hardware.

DOOR STOP.—J. JOHNSON, Fox Lake, N. D. An object of this inventor is to provide a door stop for releasably securing a door to a wall or the like, to hold the same in open position. For this purpose use is made of a gripping member, and a trip member for releasing the former, to grip the door when the trip member is engaged by the door.

Household Utilities.

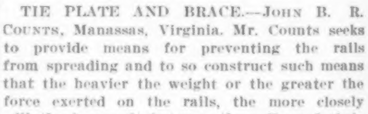
SAD IRON HEATER.—J. B. GORGEN, Terre Haute, Ind. This invention provides a double faced iron and a heater supporting handle to permit reversal of the iron; provides for heating the upwardly disposed surface of the iron while the lower is being utilized in ironing; provides an air-cooled handle to limit heat transference from iron to handle; and provides an air-cooled supporting member for the heater within the handle.

FLY TRAP.—H. SAYLES, New York, N. Y. This invention refers to traps for catching flies and other insects and the like, and has reference more particularly to a device comprising a casing, a movable member to attract flies and to carry them to a predetermined point, a cage, and means for dislodging the flies from the first-mentioned member and for directing them into the cage.

Railways and Their Accessories.

CAR DOOR.—P. J. HUOT, Kankakee, Ill. The inventor's aim is to provide a freight car door adapted to constitute a snug fitting closure member for the car and adapted to be releasably held in a locked position on the car. For this purpose, use is made of a rail, a supporting means mounted to slide on the rail, a door mounted to swing on the supporting means, a cam on the door, and a locking bar engaging the cam to releasably hold the door in a locked position.

TIE PLATE AND BRACE.—JOHN B. R. COUNTS, Manassas, Virginia. Mr. Counts seeks to provide means for preventing the rails from spreading and to so construct such means that the heavier the weight or the greater the force exerted on the rails, the more closely will the braces fit between the rails and their

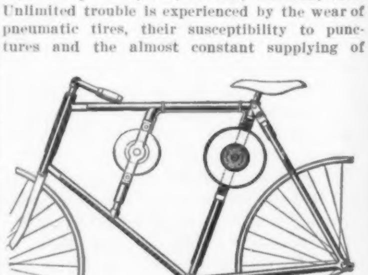


TIE PLATE AND BRACE.

supports, thus preventing the braces from slipping. The invention illustrated herewith also renders practicable the use of much softer wood for ties than now practicable, as well as smaller ties, and their life will be much increased as the spikes will rarely, if ever, have to be removed.

Pertaining to Vehicles.

VEHICLE.—CARLOS ESCALANTE, and JOSÉ P. SIRGADO, 342 West 23rd Street, New York, N. Y., and Apartado, 218, Merida, Yucatan, Mex. Unlimited trouble is experienced by the wear of pneumatic tires, their susceptibility to punctures and the almost constant supplying of



DEVICE FOR REDUCING SHOCK OR JAR.

air to the tires to preserve the object for which the tire is constructed. In this invention shown herewith a vehicle is provided having solid tires, preferably of rubber, and adapted to withstand hard usage, and in order to supply a cushion for that portion of the frame upon which the operator sits, a pneumatic device is mounted on the frame so that any shock transmitted to the frame by the wheels are absorbed by the device on the frame.

INQUIRY COLUMN

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. There is no charge for this service. **In every case it is necessary to give the number of the inquiry.** Where manufacturers do not respond promptly the inquiry **may** be repeated.

MUNN & CO., Inc.

Inquiry No. 9227.—Wanted, a power-driven saw for cutting down pine trees twenty inches in diameter.

Inquiry No. 9228.—Wanted, to buy fabric tufting machines.

Inquiry No. 9229.—Wanted, addresses of manufacturers of an alloy called Duraluminum.

Inquiry No. 9231.—Wanted, addresses of owners of water falls having a four-foot fall and upwards.

Inquiry No. 9232.—Wanted, addresses of manufacturers of engines that can be run with crude oil.

Inquiry No. 9233. Wanted, a roller or other device for skinning a beef in rapid, economical manner.

Inquiry No 9234. Wanted a small specialty of universal salability to sell from $3 to $10. Proper articles can be financed.

Inquiry No. 9235.—Wanted, names and addresses of manufacturers of machinery and appliances for making celluloid.

Inquiry No. 9236.—Wanted, the name and address of the firm making the New England Filling Machine.

Inquiry No. 9237.—Wanted, information relative to the Parmelee Automatic Aerated Water Still and Sterilizer.

Inquiry No. 9238. Wanted, addresses of those who own deposits of rottenstone, lump pumice, infusorial earth or rubbing stone.

Inquiry No. 9239.—Wanted, addresses of parties who can ship ores containing any of the following elements Vanadium, molybdenum, uranium, tungsten, titanium.

Inquiry No. 9240.—Wanted, addresses of owners of limestone beds running not less than 98 per cent, and near a railway.

Inquiry No. 9241.—Wanted, addresses of owners of deposits of molders' sand suitable for heavy castings.

Inquiry No. 9242.—Wanted, addresses of makers of bag valves.

Notes and Queries.

Kindly keep your queries on separate sheets of paper when corresponding about such matters as patents, subscriptions, books, etc. This will greatly facilitate answering your questions, as in many cases they have to be referred to experts. The full name and address should be given on every sheet. No attention will be paid to unsigned queries. Full hints to correspondents are printed from time to time and will be mailed on request.

(12432) **J. M. H. asks:** I have been looking for some time for an explanation of the chemical theory of the Nodon valve or rectifier in which aluminium and lead plates and ammonium phosphate are used to convert an alternating electric current into a direct current. A. The peculiar action of an electrolytic rectifier with aluminium and lead plates is due to the fact that the element of the alternating current which passes in at the lead plate and out at the aluminium plate experiences very little resistance from the plates; but the element which passes in at the aluminium plate and out at the lead plate meets great resistance from the aluminium plate. This is due to the thin film of non-conducting aluminium oxide which forms instantly upon the attempt of the current to pass. The negative oxygen travels against the current and meets the aluminium plate, oxidizes it, and stops the current. Half of the alternations are thus suppressed, and the remaining half are in the same direction, in at the lead and out at the aluminium plate. You will find this in our SUPPLEMENT No. 1644, price ten cents, in which a good form of rectifier is fully described and its construction given, with drawings and specifications.

(12433) **L. F. P. asks:** In the issue of January 21st was query No. 12355, relative to cleaning silver by boiling the articles to be cleaned in an aluminium kettle. The answer to this is that the action is electrical, and the surface of the silver is removed and a fresh surface of silver left. Now what puzzles me is about the fresh surface. But I think it means simply that the discoloration is removed, and leaves, not a new silver surface, but the same silver cleaned and freshened. A. By "fresh surface" of silver left after the cleaning, we meant that some of the silver on the surface is removed and a new surface of silver is left exposed. In time this will remove an appreciable portion of the silver, but the silver taken off at one cleaning would be very little indeed. Nor is there any solution which will remove the dirt and tarnish from silver by mere immersion, unless it is an acid sufficiently strong to dissolve some of the silver and in time make the surface of the silver rough. We did not suppose you referred to any such solution in your inquiry, but to a solution which would not harm the article. We should answer the same now. There is no solution which will make a new polish on silver by immersion simply which will not dissolve off some of the silver also, and injure the article.

(12434) **A. W. A. writes:** Will you please give me information as to how banana oil is made, and what part of the plant is used? Also its market value. Is it made from any other substance than the banana? Is there a treatise published on its manufacture? Any information will be appreciated. A. Banana oil is the name given to an artificial fruit flavor, which consists of a mixture of amyl acetate and ethyl butyrate. It is not made from the banana or any part of the banana tree. Amyl acetate, the principal component, is made from purified fusel oil by distilling it with strong sulphuric acid and calcium acetate. A pamphlet has been published by the United States Department of Agriculture, Bureau of Plant Industry (Bulletin No. 195) dealing with the production of volatile oils in the United States. This, however, relates to the extraction of such oils from vegetable sources, and does not, therefore, have any bearing upon the manufacture of banana oil. Any of the larger handbooks of organic chemistry describes the preparation of amyl acetate and similar substances, the so-called "esters."

(12435) **G. W. M. asks:** It is desired to pump water over a hill about 350 feet high to an outlet 14 feet lower than the top of the hill. Is anything gained, except a slightly shorter length of pipe, by making a ditch 14 feet deep, so that the last part of the pipe is level, instead of going over the top of the hill? The water is to be pumped through a 12-inch pipe at the rate of 1,200 gallons a minute. I suppose there is some good reason why balloons do not carry as part of their ballast compressed gas to replace losses. What is that good reason? A. If you lay the pipe over the hill above grade, the upper portion will be a siphon, and will collect air at the top of the bend, where it must be removed from time to time to get the benefit of the siphon lift. Whenever air collects in the bend and breaks the siphon vacuum, your pump will have to lift the extra fourteen feet. Did you ever think of the weight of the steel tube containing the proposed reserve of compressed gas for the balloon. This would be fatal. There would be much risk of injuring property or destroying life. Sand has stood the test of time.

Light and Shadows

(*Continued from page 375.*)

gotten from the several views of rooms lighted by these fixtures shown herewith. The simple style of fixture is well shown in the illustration of the offices of the Hamilton National Bank of Chicago. Here the ceilings are ivory with gold decorations, and the walls are white enamel down to the wainscoting, which is marble.

In the home we generally want bright light only over a small space such as the dining table, the dressing table or the reading chair, while a very low intensity suffices in other parts of the room. Even when a whole room is to be lighted a cozy, restful illumination is more easily obtained by a number of small lamps than by a single large one, and usually it is preferable to avoid glare by use of shades rather than by indirect lighting. In some cases, however, as for instance when the number of outlets is limited, it may be advisable to use a single large high-efficiency lamp in an indirect lighting fixture near the center of the room. If the ceilings and walls are light colored and a good reflector is used, one 100-watt lamp will light a room fifteen feet square or smaller fairly well; if more outlets are available a still more attractive effect is obtained by using a somewhat smaller lamp for the indirect fixture, supplementing it with one or two small direct lights.

While most of us have a predilection for the shaded direct lamp, illumination is, after all, largely a matter of taste, and it must be admitted that most charming results can be obtained by indirect lighting in the home. Light walls are by no means indispensable; for example, in the living room shown, which is 15 × 22 feet, the walls and hangings are dark green, yet the two-light fixture gives an illumination by which fine print can be read with perfect ease. The dining room given is an extreme case in that all the finishing except the panels of the ceiling is very dark. Even here four 60-watt lamps are sufficient for a room 15 × 20 feet.

In the second living room shown, which is 15 × 23 feet, the bowl fixture contains six 40-watt lamps, arranged so that either two, four, or all six may be used.

In efficiency indirect-fixtures lighting can be made to excel either the cove or the "direct-indirect," and while it is necessarily less efficient, in the engineer's sense of the word, than well-planned direct lighting, the power consumption is by no means excessive. As an example, the new building of the Portland (Oregon) Railway, Light and Power Co., where the ceilings are ivory and the walls a light tan, is satisfactorily lighted throughout with this system with an expenditure of 1.1 to 2.5 watts per square foot, which would be a rather moderate allowance for a building of this sort if lighted directly with good carbon lamps.

In the Hamilton National Bank the indirect system is not merely more satisfactory, but actually uses 30 per cent less power than the former direct installation.

In conclusion it may be said that the problems of illuminating engineering are far from solution, and opinions differ widely as to the relative merits of various plans and devices. It would be premature to assign to indirect lighting a definite rank, but it is certainly worthy of serious consideration for its artistic possibilities and as a long step forward in the movement toward the conservation of eyesight.

Good Coal and Poor

(*Continued from page 376.*)

der the condition that if the coal delivered is above the standard, the seller of the coal receives a premium, and if below the standard, the seller of the coal pays a penalty, in proportion.

In some cases the standard is based upon the number of heat units alone; in other cases upon the heat units and the percentage of ash; in still other cases the heat units, percentage of ash, volatile matter, sulphur and moisture are all considered. A desirable tendency is toward simplifying the specification, basing it upon the heat units alone, but providing that if the heat units fall below a certain figure, or if the ash forms a serious slag on the grate bars, or if the coal smokes

badly and beyond reasonable remedy, the contract will be canceled.

There are certain difficulties in the way that retard the general adoption of such a specification in the purchase of coal. The most serious of these difficulties is the collection of a fair sample of the coal to be analyzed. This is especially true where the sample must be collected from coal already loaded in cars, on board ships, or stored in large bins. In these and in other cases the collection of a fair sample is more difficult than the making of an accurate analysis; but it is also important that in the work of the chemist only standard equipment and standard methods should be used—and by experienced chemists.

In endeavoring to predict from a chemical analysis (B.t.u.'s) the efficiency with which a given coal will burn in the furnace, the greatest factor of uncertainty is the behavior of the ash; whether or not it will melt and form a slag on the grate bars. Another factor of uncertainty is the behavior of the coal itself; whether it will cake on the upper surface in burning sufficiently to interfere with the draft (and the combustion).

When our knowledge concerning this and other less important matters is advanced sufficiently, instead of purchasing coal as we now do at a given price per ton, we will be able to purchase it on the basis of a given price per one thousand heat units.

Heating the Home

(Continued from page 378.)

pense and insure successful operation. Consider the climate of the locality, the temperature, whether mild or extremely cold, the location of the house, whether detached or in an exposed position, the size and height of the chimney, the height of the cellar ceiling, the amount of glass or window exposure. Allowances should be made for loosely fitting windows, etc. Finally consider the fuel at hand. Tabulate these details and submit them to the heater manufacturer. If it is a small compact house of one or two stories (any climate) the hot air furnace will provide ample heat and prove satisfactorily economical and lowest in cost of installing. It has much to commend it for this class of heating. It is simple with practically nothing to go wrong, and the repairs are low in cost and readily made. See to it that all pipes leading from furnace are sharply slanted upward. Do not allow square end elbows to be used. Sharp corners or bends in warm-air pipes neutralize to some extent the natural active tendency of warm air to rise and circulate. If the house is long and narrow place the heater as indicated, thus permitting all pipes to be given a sharp upward rise. (See Figs. 3 and 4.) If the ceiling is low set the furnace in a pit to necessary depth to give upward slant to all pipes as they leave the furnace. Fit a baffle plate as shown in Fig. 3 to extend into furnace. It will cause the air to be distributed over a greater section of the furnace heating surfaces. As now generally installed, fresh air passes to the upper heating drum, up one side of the furnace in a compact thick body, thus only its outer skin is warmed. This baffle plate will increase the efficiency of this style of heater.

The heating requirements of every style and size of house are readily met by steam and hot water systems. There are three distinct methods of applying steam and hot water heat to the home. These are known as the direct-heating method, direct-indirect-heating method, and the indirect-heating method.

The direct method used with steam or hot water is the least complicated, is positive in action, and is very efficient. It is lowest in cost of installation and in many other respects most desirable. This method is very easily installed, and there is less heat loss in transmission with this system. Radiators are placed directly in rooms to be heated, and no direct fresh air supply is furnished. It is important, however, as previously stated, that a fresh air regulating ventilator be provided for each room. The loss of space occupied by radiators and the absence of connected ventilators is amply compensated for by the many other advantages. The direct system is considered most practical for the average

home heating requirements and is very generally installed.

The direct-indirect method for steam or hot water accomplishes the same result as the indirect system when provided with some independent form of ventilation. With the direct-indirect method (Fig. 5) fresh air is taken through the wall from out doors, at the bottom of radiators, and is heated by passing up through the radiators into the room.

Individual regulation of temperature in each room can be had by a convenient damper, arranged to cut off outside air and permit circulation in the room.

Fresh air circulation is readily secured with this system, the loss of space occupied by the radiators and the increased operating cost being the sole disadvantages. The direct-indirect system requires about forty per cent more radiating surfaces than the direct system, though less than the indirect system.

In the indirect method (Fig. 6) used with steam or hot water the radiators are placed in a box, compartment or small room—in the cellar or any convenient place, below the room to be heated. Fresh air from outdoors enters and passes through radiators—being heated before reaching the room. This system of heating is more expensive in operation than the direct or direct-indirect system. Where space is at a premium and a good circulation of air is essential this system is unsurpassed. However, greatly increased boiler and radiating surfaces are necessary where this system is used, to insure the desired temperature.

Heating by electricity is the most attractive heating method yet devised, but unfortunately the cost of electricity is as yet too high for general use. Its convenience for chilly days—when a furnace fire is not warranted—is, when one takes into account its cleanliness, the most valuable addition to any heating system. In very mild climates, no doubt electricity can be used advantageously, particularly where cool nights prevail and the days are unusually warm.

Of the above described methods of applying heat, it will be found that steam gives the best results, particularly in cold climates and where difficult piping conditions prevail. Tests made by authorities of both steam and hot water heating systems under identical conditions show considerable saving in favor of the economy of steam heating systems. However, the question is still debated to some extent and possibly where certain conditions of piping or mild climates are met hot water might prove as economical as steam.

The slight pressure at which steam is used in home heating plants easily overcomes many conditions that are often fatal stumbling blocks to the successful operation of hot water systems. Abrupt bends, numerous difficult turns often necessary to place radiators in desired positions, impede water circulation, but do not appreciably affect the travel of steam under the pressure generated in home heating plants. The use of steam with the direct method of heating requires only single lines of vertical piping above the cellar connecting the boiler direct with the radiators placed in the rooms.

It is the most simple system, as no top floor or attic piping or fittings are required with steam, as is the case with hot water systems. Hot water used in the direct heating method requires radiators with about fifty per cent more radiating surface than is required for steam.

Increased boiler heating capacity is also necessary to heat a room of stated size to the same temperature as with steam. With the direct method, the added space occupied by the increase in size of radiators with hot water is offset, in the opinion of many, by the evenness of the heat and slight attention required. The fact that hot water radiators retain some warmth over night, even though drafts are cut off, particularly commends it, as the house never becomes entirely chilled. This convenience is greatly in its favor.

In the use of fuels we must be governed by the supply at hand, and it is well to keep this in mind when purchasing. If it is desired to burn soft coal a larger grate surface is required, due to the lessened draft by caking of the coal. A larger grate surface is also necessary for fine, hard coal, such as pea

or buckwheat. If this is provided they will give as much heat as the larger sizes. Stove size anthracite coal will prove to give the best results. To burn fuel slowly is the right and most economical method, but requires increased boiler grate surface. It pays to provide it. The price of gasoline and naphtha is declining, though it is not yet low enough to make the gas produced by equalizing gas machines available for home heating, while it has already proven its economy over city made gas for cooking. Gas is more convenient and has proven that less loss of meat juices takes place with gas cooking than with coal. The lowering of the price of gasoline and naphtha which is predicted should make naphtha gas available for general fuel and prove a boon to the man with a furnace to attend.

City gas will, of course, remain supreme in city and nearby districts for cooking, when economy is considered, but electricity is rapidly extending its field in the kitchen by development of cooking appliances that are economical in consumption of current.

Here are a few heating facts to remember: Wooden buildings properly built can be heated with no more expenditure of heat than a brick building. In selecting a boiler, bear in mind that large water passages are required. They are necessary to permit the rapid escape through the water of the steam globules. A certain manufacturer provides his heaters with damper regulating diaphragm tubes below water line. This improvement saves expense and trouble, and insures positive action. Be sure to place some good make of automatic air valves in your radiators. Cheapness is costly. See to it that the size of chimney fits your furnace or can be made to fit. Consult the manufacturer as to the proper chimney sizes. Do not permit the flue pipe from the furnace to extend beyond the chimney wall into the air space. Particularly in case of hot water it is advocated that pipes be put in boxes recessed in the wall. This prevents, in case of leakage, any damage to the house proper. Some additional efficiency is gained by having steam pipes pass through rooms, though they are unsightly. In painting radiators remember that both color and surface produced directly affect the radiating capacity. Dark paint and rough surfaces are most effective conductors of heat. Glossy bright paint or silver finish (smooth) cuts down radiating ability, while enamel is most wasteful, producing the poorest radiating surface.

Trouble Chart.—Hammering in radiators and piping is due to a vacuum caused by water accumulating to such an extent as to quickly condense some of the steam. To cure it raise the radiator on the side opposite the inlet pipe with small block of wood. Cold radiators are due to air blocking, and in case of hot water system to steam clogged or improperly adjusted valves. Air should be released occasionally with the key provided with hot water systems, unless fitted with automatic valves. In the steam system, clean out the valve and unscrew the valve seat until the steam escapes rapidly. Permit the flow to continue for a minute or two, then screw down the valve seat until the steam is just cut off.

Lamps of To-day

(*Continued from page 379.*)

she may inspect it by daylight, since the amount of daylight that penetrates into the store, or the artificial lighting, does not satisfy the eye when it comes to deciding on the color and texture of the prospective purchase. The lithographer and color type engraver is enabled to guard against false values that would throw his work out of true and also to increase his production on dark days or to complete "rush work" by virtually stretching out the daylight hours. The portrait painter and the photographer, who find the light failing them in the full swing of their work, may by its aid keep at work indefinitely or may take it up whenever the inspiration comes—even at two o'clock in the morning if necessary. The appliance should be a boon to the textile manufacturer, the haberdasher, the rug dealer, etc., all of whom need a more constant and plenteous illumination of true color value, for the efficient conduct of their businesses.

The most efficient tungsten incandescent lamps of the General Electric Company consume 1 to 1.25 watts per horizontal candle power—a very low figure compared with the 3.1 to 3.5 watts per candle of the graphitized carbon lamp. The effectiveness of all electric light sources is increased by the intelligent application of certain new shades and reflectors for distributing the light, which throw the light in any desired direction by the reflective and refractive effect of a set of prisms formed in the surface of the glass, and radial wave reflectors, which increase the efficiency for street lighting by scattering the light over a large area.

One drawback of tungsten lamps hitherto has been the fragility of the filaments of lamps for ordinary voltages. The drawn wire filament now coming into use—made available by a process developed at the laboratory of the National Electric Lamp Association—and improved methods of anchoring the filament mark the highest development of this lighting unit. They permit the construction of a high-voltage lamp which compares favorably as regards the robustness of the filament with the most approved type of carbon lamp.

The quartz lamp, developed by Kuech, Bussmann, and others in Germany, is a mercury vapor lamp having a quartz tube, which permits the light to be operated at a high temperature (5,000 or 6,000 deg. C.) and therefore with high efficiency. The specific consumption is given as 0.25 watt per candle, and the life as 2,000 to 6,000 hours, depending on the current density employed. As in the case of other mercury vapor lamps, the lamp mechanism serves only for starting the arc, and is therefore very simple and little subject to wear and derangement. The quartz lamp was introduced for street lighting in Paris last summer, notwithstanding the fragility of the quartz tubes and the supposed necessity of cutting off the ultra-violet rays emitted by the mercury arc and which pass readily through the quartz tube.

Among new electric lamps which have not as yet been put into commercial use is an arc lamp having a negative electrode of titanium carbide placed below a non-wasting copper positive electrode, and giving a light which is almost pure white. Dr. Charles P. Steinmetz has recently patented an arc lamp having one electrode of mercury and one of aluminium. An incandescent lamp, utilizing a highly refractory filament which is so slowly oxidized that it can burn for a considerable number of hours without a vacuum globe, was announced a few years ago by its American inventors, Messrs. Parker and Clarke. The specific resistance of the filament, which consisted of a carbon base with a silicon coating, was stated to be about fifty times that of an ordinary carbon filament and several hundred times that of the tungsten lamp, and its hardness is claimed to be so great that it would scratch glass.

But if electrical methods of lighting have made great strides, progress has not been wanting in the field of other illuminants.

The light of the tungsten lamp has recently been paralleled in gas lighting by the introduction of a new mantle which replaces the dead whiteness formerly characteristic of the incandescent gas mantle by a light of amber tone. The amber light mantle is a structure of modified chemical composition differing from the ordinary thorium-cerium formula and giving a warmer, more mellow light which matches up with that of the tungsten filament. For the base fabric, the highest grade and most enduring ramie fiber must be utilized, as this fiber only gives a mantle of permanent color-value and candle-power and of sufficient mechanical strength. Small sizes of inverted lamps and mantles (20 to 40 candle-power) are now made which will go far toward popularizing this new light in competition with electricity, and to establish gas—from time immemorial the great home illuminant—more firmly than ever for general lighting purposes. By the aid of these small units, and the new pilot-light pneumatic and electric distant-control gas switches, all of the outlets of the ordinary three-burner or four-burner fixture can be operated to advan-

tage, giving a more harmonious effect and better distribution of illumination than is possible from a single ordinary-sized burner. High-pressure gas for street lighting with incandescent mantles has had satisfactory application in Europe, notably in Berlin. Inverted mantles are employed, with special precautions to secure reliability. For instance, the burner, mixing chamber and top of the lamp have to be unusually massive in order to avoid overheating from their exposure to the burned gas; and the size of the mixing chamber and design of the chimney has to be such as would insure the best conditions with the required consumption of gas (600 to 1,200 liters), and make the lamp windproof. It was found advantageous to employ two mantles on the burner, one inclosing the other; the light from the inner one passing through the meshes of the outer one and the combined light emission being greater than that given by a single mantle.

Blaugas, to which the name "bottled sunshine" has been applied, is a heating and lighting gas of German invention chiefly remarkable for the unique manner of its application. It is sold in liquefied form in strong steel tanks or bottles 8 inches in diameter and 4 feet high, containing 20 pounds of the gas. It is stated that one pound of this gas, costing ten cents, will keep an ordinary 60-candle-power gas mantle burning for 17 hours, making a bottle of the gas the equivalent of about 1,000 cubic feet of ordinary city gas. The portability of this novel illuminant renders it especially adapted for use in country or suburban territory where there is no central gas plant with street mains. The equipment for using it consists of a small steel cabinet installed just outside the house, holding two bottles of the gas and an expansion tank from which the house piping is supplied.

An improvement in lighting by denatured alcohol by the Graetzin system, in which the German Emperor has taken such an interest, has recently been made, in the form of a new incandescent mantle lamp of simplified construction. This light-source gives shadowless illumination at moderate cost, and should be of interest to thousands of families throughout the United States which are now dependent on kerosene or candles, since pyro-denatured alcohol at 50 cents a gallon is a smokeless and odorless fuel which is capable of bringing out to the full the excellent qualities of the Welsbach inverted mantle. The first practicable lamps employed an ordinary upright mantle, with a lamp-wick feed like an ordinary kerosene lamp, and a "priming device" to start the generation of vapor.

The present improvement consists in a gravity feed from a reservoir above the burner, delivering the vapor to an inverted mantle and doing away with the wick and the priming pump. In the overhead lamps designed for outdoor and indoor use, a pull on the hanging chain permits the priming charge to run down on to the heating surface, and in a few seconds the vapor generated ignites at the outlet of a Bunsen burner giving a hot flame which brings the mantle to full incandescence. A mantle of 99 per cent thorium and 1 per cent cerium, on a ramie fiber base, is employed. The outdoor lamp is of windproof construction.

Light and Power on the Farm

(*Continued from page 390.*)

the best results. The small farm is generally situated within feasible transmission distance of a central station, or can secure current from an electric railway system, from either of which sources current may be had without the installation of a private generating plant. The charge for electricity from such a source is often high, and the service is not especially reliable, but, nevertheless, these faults are not necessarily serious, as the uses to which the small farmer would have occasion to apply electricity are principally for lighting, separating and churning, light lathe work, feed grinding, clipping and grooming, wood sawing, grindstone work, and the usual domestic conveniences, laundry work, sewing machine work, ice cream freezing and many other devices requiring small amount of power, also the toasting, cooking and heating articles now made by several manufacturers.

It is the larger farm proposition that offers the greater opportunity for the application of electricity, for not only are the various domestic conveniences desired, but in the farming operations there is a real opportunity to increase the rate of output and decrease the amount of labor involved in producing the crops, transporting labor and materials in the fields and buildings, plowing, threshing, silage making, milking, pumping, refrigerating, and incubating.

With an equipment producing the most modern method of accomplishing all the operations that go to make up the routine of a grain, dairy or stock farm, the owner can afford to employ skilled labor and just as much of it as he can provide productive work for, because in this way the profits will be greater through increased output and the fields will have to be stimulated to their utmost to produce the material necessary to keep the machines up to a full period of operation.

The key note then becomes reliability of operation. This means adherence to a definite schedule of work, the substitution of more capable labor in the place of the unskilled farm worker, and the adoption of highly efficient mechanical devices which will eliminate, either wholly or in part, manual labor and accomplish, in a given time, results that before their introduction would have seemed amazing.

It is no longer a matter of prophecy to say that electricity on the farm will do these things, for it has been proven, and every day the ways in which advantage may be taken of the usefulness of this great force are becoming more and more numerous. The saving in labor cost of a great variety of operations and the rendering of other economies in production make it of the greatest importance to the farmer.

The important applications of electricity on the farm have been pretty well described and demonstrated in agricultural experiments, farm journals and lectures on the subject. The salient points which have been brought out by these demonstrations being:

Electric lighting and motor drive for all extensive field and barn operations is feasible with the apparatus now to be found in the commercial market.

By the adoption of one system for transmitting, utilizing and controlling the energy required for both light and power, as is possible only with electricity, an organization of equipment is provided that cannot even be approached by the combination of any other means.

The use of electric power as a substitute for the individual engines often installed in barns and outbuildings has the advantage of greater reliability, safety, cleanliness and flexibility in application.

The expense of electric wiring and motor equipments are not excessive as compared with the cost of other equipments.

The installation of electrical apparatus on any farm will pay for itself in the saving over the old method in the first season.

The economy of the proposition is the strongest argument.

For those farms on which central station current cannot be obtained or for problems of any considerable size, involving one hundred acres or more, generating sets, utilizing prime movers must be installed.

The accompanying illustrations show the apparatus which should be included in a well ordered plant of this kind.

For the farm equipped with steam boilers, or accessible to cheap fuel, the small steam engine or turbine generator sets are the most suitable, but, for the majority of farms this is not the condition, and the gasoline, kerosene, or other fuel oil, internal combustion engine is more appropriate, on account of its greater simplicity and safety.

Two of the accompanying illustrations show typical generating units of this kind.

With the private electric plant there is the utmost need for a proper planning before the apparatus is ordered, as the standards of manufacture in this particular class of machinery offer an infinite number of sizes and styles to select from, each combination having certain limitations and possibly a particular purpose, thus making it a very easy thing for

the purchaser to select something quite unsuited to his needs. The electric generating plant should, therefore, be well designed, for it is destined to become the very heart of the successful farm. A mistake in the planning or the selection of the fundamental characteristics of the system that is to be employed can seldom be corrected after installation, and would, doubtless, involve continued unnecessary cost of operation and upkeep.

Fig. 1 shows a very good example of the larger capacity equipments, suitable for supplying current in considerable quantities, and illustrates a three-cylinder engine with direct connected dynamo and a very complete and somewhat ornamental switchboard for controlling the supply of electricity to a large group of farm buildings.

Fig. 2 illustrates a smaller and less elaborate, but none the less serviceable, power plant in which the general arrangement is quite compact. The storage battery, which serves as an excellent auxiliary in installations of this kind, is located in the engine room, but it is inclosed in glass to prevent the escape of the acid fumes.

There are many forms which the power plant equipment may assume, and each installation must be determined on the basis of the limitations that exist with respect to location, distance the current must be transmitted and period of service.

An important item of the farm equipment that should be placed in the electric plant and always kept in immediately operative condition is a pressure pump of sufficient capacity to provide ample fire protection for all buildings and crops in storage. The value of property lost by fire can be recovered from insurance, but the loss of the opportunity for profit from business during the period of rebuilding is not so easily taken care of.

Fig. 3 illustrates an ideal pumping equipment for this purpose, as it may be driven by either the internal combustion engine with which it is directly connected, or by an electric motor which cannot be distinguished, owing to the point from which the photograph was taken. With this equipment, if the electric generating apparatus is not running, the pump may be operated for its ordinary duties by its own gasoline engine, or from the storage battery, which latter, however, is not so efficient a method. In case of fire, the pump can instantly be set in motion, as it is also connected with the electric generators at the switchboard, and thus has three sources of energy to draw from.

Inventing the Light of the Future

(Continued from page 388.)

The second way is to increase the temperature. The problem here is to find the proper materials. The temperature of a gas flame has been increased by using a gas of higher energy, such as acetylene, and also by increasing the rapidity of combustion. The temperature of the lamp filament has been increased by substituting for the carbon some more refractory material, such as tantalum or tungsten, and by increasing the energy input. In no case can very high efficiencies by incandescence be reached because of a certain temperature limit. The actual increase in temperature need not be great to obtain a very marked increase in efficiency with present materials. What is more, the amount of current used would decrease with the rise in temperature. Unfortunately rapid deterioration also results in the case of the carbon filament. For this reason the new metallic filaments will in all likelihood displace carbon in the next few years.

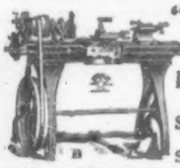
The third way of increasing efficiency of light production is to utilize incandescent bodies which do not radiate in the same manner as the carbon filament, but which give an abnormaly low amount of heat, or an abnormally high amount of visible rays. Such bodies exist, and the enormous progress in gas lighting made by the introduction of the Welsbach mantle is based on such "selective radiation," as it is called. The color of light may change with the temperature, may change from yellow to white or blue, or from green toward white or red, as the mercury light does with increasing temperature. That, however, is merely a characteristic feature of that particular body and not a general temperature effect. The possibility, therefore, exists of finding materials which, when energized as vapor or gas, will yield a spectrum with a large amount of energy in the visible range, thus giving an efficiency of light production far in excess of that available by incandescence.

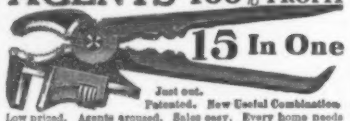
Two new photometric methods devised by Dr. Hyde indicate that the new metallic filament lamps of which we hear so much owe their high efficiency in part to some such "selectivity." Osmium, he found, radiated selectively in favor of short wave lengths, that is in favor of the visible spectrum, and is therefore a more efficient luminous radiator than a carbon filament. Next to the osmium lamp in selectivity comes the tungsten, a new type of which has recently been introduced, and has given the central station companies much concern because it reduces the amount of current consumed below the profit-making point.

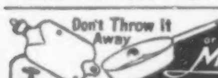
In order to ascertain whether or not a lamp is efficient or not, whether a new lamp is better than an old one, an amount of testing and study is necessary of which the public knows little. To solve the problem of gaging luminous efficiency alone, it has been necessary to devise measuring apparatus which often embodies in itself inventive ability of no mean order.

Although these light-measurers or photometers differ in form, the underlying principle and mathematical law on which they are based is usually the same. According to that law the illumination of a surface is proportional to the power of the source of light divided by the square of its distance from the surface. Among the many photometers based on this law may be mentioned the pioneer photometer of Bunsen, in which grease-spotted paper is placed between two lamps, the greased part appearing dark when viewed from that side of the lamp, which produces the stronger illumination at the position of the paper, and as a light spot when viewed from the opposite side, although it is still used in commercial work, fitted with the Ruedorff mirrors, nowadays the photometer of Lummer and Brodhun is extensively used, in which, instead of a grease spot, two rectangular prisms are employed, total reflection and total transmission taking the place of partial reflection and transmission in Bunsen's photometer, so that the contrast is sharper and the result more exact. With an improved form called the "contrast photometer," the mean error of measurement is only one-quarter per cent, while the mean error of Bunsen's photometer varies from one to three per cent. The newest of all these measuring instruments is the "flicker" photometer, which has given excellent results in the comparisons of lights of different colors, as well as of lights of the same color. It is based upon the principle that if a white surface is illuminated alternately, at intervals of one-sixteenth to one-tenth of a second by two sources of light, an appearance of unsteadiness or flickering is produced, which vanishes when the intensities of illumination from the two sources become equal. Hence, if the surface is moved to a position at which the flickering disappears, the relative powers of the sources may be computed from their distance from the surface. The flicker method is little affected by differences in the colors of the lights, for the reason that the eye does not recognize differences in color as quickly as it detects difference in intensity. The variation or flickering vanishes when the alternations become very rapid, and by selecting a frequency which destroys the difference of tint, the effect of white light is produced. By moving the lights until they illuminate the surface equally the relative candle-powers can be determined, notwithstanding the differences in color.

The more nearly the illuminant of the future will approach daylight in quality, the more nearly will the human eye be satisfied. Most, if not all, artificial lights differ from daylight, among other respects in that of color, the practical results of which are seen whenever we attempt to work with colors under artificial light. This difficulty can be met to a certain extent by designing color schemes to fit either or both illuminations. But after we have thus mastered the differences for practical purposes, im-







portant questions still remain. One of prime importance is whether lights differing widely in color from daylight are harmful to the eye. It is only by the acquisition of exact data that the part played by high intrinsic brilliancy, infra-red radiation, ultra-violet radiation, and the like can be understood. Investigations such as these can be conducted only in a purely scientific laboratory, and hence it is that the nearly perfect light of the future will be produced in accordance with principles discovered by pure science in laboratories founded with no commercial end in view. There has been developed as yet, no simple means of measuring an artificial light source in such a manner that a numerical value can be given to its approach in quality to daylight. In other words, there has been no basis for estimating the daylight efficiency. It is obviously one of the duties of the physicist to provide such a basis. That object has been at least partially attained in the laboratory at the head of which Dr. Hyde stands.

Pure science, and not engineering, must solve many a difficult problem involving color before we can arrive at the artificial sunlight of the future. What is the physiological effect of a light rich in ultra-violet rays? What is the effect of vision at the center of the retina when the source of light is directly in the field of view, and when it is placed to one side? These are important questions which only the physiologist and psychologist can answer before the engineer can give us a cheap and efficient light.

The one physiological subject of "glare" alone has involved a vast amount of painstaking study, novel in its character. There are twelve eye-muscles, six for each eye. It is their function to turn the eyeball so that its axis may point (within limits) in any direction. To see fine detail it is necessary that the image of the object of vision fall on a very limited portion of the retina known as the "fovea," specialized for distinct vision. This happens when a person looks directly at an object, and must obviously occur alike for both eyes, wherever the object is, so that the object of direct vision always falls on the fovea of each eye. The result is that images of other objects not directly looked at will fall on corresponding points of the two retinas. Now, the difficult task is thrown on these twelve muscles of accurately placing the images in the two eyes on corresponding points of the two retinas, whether the object be far or near, up or down, or off at one side, and the movement of accommodation must take place at the same time as the two eyes are directed inward in looking at a nearer object. The eyes must be focused alike and accurately converged in order that their axes may meet at the object of direct vision. So perfectly do these muscles perform all these delicate adjustments, without the least knowledge of the fact on our part, that when the image in one eye is displaced by holding a prism of three or four degrees deflection before the eye, the muscles at once make the necessary adjustment, and the knowledge of it is the disagreeable pull felt in the eye as the muscles assume the unusual strain. We have to do here with a most complicated and delicately balanced set of muscles and nervous connections, and a small but persistent disturbing circumstance may work not only great discomfort, but in extreme cases may cause such confusion of the various eye movements as to make vision well nigh impossible. Factors such as these must be considered in studying glare and in distributing light, in the proper way for practical illumination. Hence, their importance to engineers and lawmakers and to any man who seeks to improve present methods of producing and using light.

Evidently, the light of the future must be safe. Ophthalmologists tell us that many of our eye troubles are due to incorrect lighting. It is not known exactly to what extent eye injury may arise from degrees of intensity, or to what extent from spectral composition. Dr. Schanz, an oculist, and Dr. Stockhausen, an engineer in Germany, have concluded that ultra-violet light, in such quantities as it is found in many artificial sources, is positively harmful and should be eliminated. The presentation of this work before scientific and technical bodies has called forth a storm of protest. In particular, Dr. Voege, of the Staatslaboratorium, of Hamburg, has published the results of numerous experiments to show that in daylight illumination, under comparable conditions, there is more ultra-violet light than in those artificial sources which were found harmful by Drs. Schanz and Stockhausen. What conclusion, if any, shall we draw? Only the physiologist unfettered by commercial considerations can answer.

In order to see, we are not so much concerned with the amount of light that falls upon an object as with the amount of light that reaches the eye after having been thrown back from the illuminated object. Investigations such as these seem properly to fall in the province of the illuminating engineer. Yet there is a vast amount of purely scientific work to be done before we can distribute our future light in the proper way. Here again the physicist and the physiologist join hands, and here we see the necessity of a physical laboratory which shall conduct its investigations free from commercial bias.

The Current Supplement

A CRYSTAL arouses the interest of the observer, not only by the regularity of its forms, the perfection of its surfaces and angles, its transparency, and its brilliance, but also by the manner in which it grows, heals its wounds, is dissolved, and modified under the influence of the inclosing medium. All these phases of crystal life, if so it may be called, are admirably discussed by Dr. Paul Gaubert in the current SUPPLEMENT, No. 1841.—An eloquent address on language and literature was delivered not so long ago by Lord Morley. Parts of the address dealt with the relation between science and letters and are commented upon in the current SUPPLEMENT.—Mr. Walter V. Turner's paper on "The Airbrake as Related to Progress in Locomotion" is concluded.—Most interesting, both because of its manner of presentation and because of its remarkable illustrations, is an article by Mr. A. Hooton Blackiston on Antigua, a remarkable Central American city of historical interest.—A paper recently read by Harrington Emerson, the eminent efficiency engineer, before Harvard University, on "Securing Efficiency in Railroad Work," is published.—The Hanriot monoplane is described, and detail drawings of its construction published.—Mr. W. C. Getz contributes a good article on the working distances of wireless stations.—The pollution of our streams by sewage and trade wastes has become a national issue. Hence, Mr. H. de V. Parsons's scathing paper entitled "Our Typhoid Streams" should be read with profit.

Tipping the Shores of Hudson Bay

A VERY curious result of the slow change of level going on at various points of the earth's surface is the gradual tipping up of the shores of Hudson Bay, just as if some gigantic power were engaged in an attempt to empty that great basin of water into the adjoining sea. One of the earliest indications of what was transpiring in this connection came to the notice of the officers of the Hudson Bay Company when they found that the water at the mouths of the rivers where their posts were stationed was gradually getting shallower and navigation consequently becoming more difficult. Examination showed that the shore is lined with old beaches of sand and gravel lying as high as fifty feet or more above the present level of the bay. When Hendrik Hudson, in 1610, discovered the great body of water that bears his name, he wintered with his ships on the east coast of the bay in a harbor which has now disappeared, or at least has been so far drained off as no longer to be recognizable from his description.

An Astrophysical Observatory in Mexico.—The Astrophysical Observatory of the Smithsonian Institution is now seeking a location in Mexico for a high-level observatory, at which observations of solar radiation may be carried out under favorable atmospheric conditions.

Science

Japanese Lacquer.—Japanese lacquer is held to be the most beautiful material of the kind in the world. It has recently been the subject of a special study by German chemists, the result of whose investigations is of interest. The special qualities of Japanese lacquer are its brilliance, its great hardness and toughness, and its resistance to acids, alcohol and boiling water. It is made of the gum of the *Rhus vernicifera*, which grows and is cultivated in China as well as in Japan, and may be seen as an ornamental tree in Europe. The best gum comes from the foot of the tree in the hottest weather of the summer. The art of bleeding the trees has been carefully cultivated, as well as that of preparing and coloring the lacquer. Finely pulverized mineral salts, as well as carbon, gold and silver, are employed in producing polychromatic effects.

The Will of Sir Francis Galton.—By the will of Sir Francis Galton, who died on January 17th last, the sum of $225,000 is set aside for the establishment at London University of a chair of eugenics. It was Galton's idea that data should be collected which would help along the cause of eugenics. With characteristic thoroughness, he provided means for rendering the information accessible to scientific workers in the field.

Cessation of Work at Arequipa.—Prof. E. C. Pickering, director of the Harvard Astronomical Observatory, states in his annual report that it will be necessary to abandon the work at Arequipa, Peru, for lack of funds. We share his hope that only a partial abandonment of the work there will be necessary, until some broad-minded man of wealth will furnish the necessary money to carry on investigations in the southern hemisphere, where little astronomical work is done.

The Department of Agriculture and New Fruits.—The attention of the Department of Agriculture has been called to a dispatch published in various California papers stating that the department had originated a new type of navel orange and that several thousand young trees were ready for distribution this month throughout California. These statements as published are misleading and are apparently based on a misapprehension of the facts. The department has no new navel oranges nor new citrus fruits of any kind for distribution in California at present. Experiments in the breeding of new navel oranges and other citrus fruits have been under way for several years, but these experiments are still in the preliminary stage. None of the new sorts will be distributed until thoroughly tested under the auspices of the department and found to be of promise. None of them has as yet fruited, therefore it is not known whether any will be of commercial value.

Marketing a Glacier.—The rather poetic term *houille blanche* ("white coal") is applied in France to the Alpine glacier ice, because of the mechanical power supplied by the streams to which it gives rise. One of the greatest of these rivers of ice is the Glacier des Bossons, on the northern slope of Mont Blanc, at Chamouni. Within recent years this glacier has become a source of supply of ice for domestic purposes. More than 100,000 pounds of the glacier ice is sent to Lyons every summer. It is remarkable for its extreme purity. The ice is detached from the mass of glacier in blocks of suitable size by exploding gun powder in drilled holes. Dynamite was tried, but it shattered the ice, and also imparted to it an objectionable yellow tinge.

Meteorology in Greece.—During the past decade an efficient meteorological service has been built up in Greece, chiefly through the exertions of Prof. Demetrius Eginitis, director of the National Observatory at Athens. The fifth volume of the annals of this observatory, just published, is a work of some 600 quarto pages, far the greater part of which is devoted to meteorology. It is published in French. Prof. Eginitis has also published, in Greek, two volumes of what is planned to be an exhaustive treatise on the climate of his country. He has also written, in Greek, a general work on meteorology (*Πρακτικη Μετεωρολογια*) which has already passed through two editions.

Electricity

Words in the Telephone.—Long-distance telephoning has become a little science on its own account, and has called into existence a class of operators who are valuable by reason of the clearness and sharpness with which they can pronounce words while speaking rapidly. It has also developed the fact that the French language is better adapted to the purposes of the telephone than the English. The ordinary business of the long-distance telephone between Paris and London is frequently carried on in the French language. It is stated that the considerable proportion of sibilant or hissing syllables in English renders it a less easy and accurate means of communication. Certain English words are especially difficult of transmission by telephone. The word "soldier" is cited as one of these. Proper names frequently occur, in the midst of an otherwise perfectly audible and intelligible conversation, which the ear cannot catch. These must be spelled out, involving delay. Expert 'phone operators in the Reuter press service between Paris and London have succeeded in transmitting messages in the French language at the rate of one hundred and ninety words a minute. This is at a much swifter rate than ordinary speech.

Measuring the Bore of Fine Capillary Tubes.—The task of measuring the inside diameter of a capillary tube is a very delicate one. The usual method consists in measuring it optically with a microscope and micrometer eyepiece, or by filling it with a measured weight of mercury, and determining the space occupied by this quantity of mercury in the tube. A new method has recently been suggested, which consists in passing a current through the mercury and determining the mean diameter of the mercury column by noting its electrical resistance. This has proved to be a very correct way of measuring the tube, but it is open to one difficulty. The tube must be kept perfectly clean and free from moisture, so that the resistance will give a true measure of the diameter of the mercury.

Electrical Exports in February.—According to statistics furnished by the government for February last, there has been a falling off of electrical exports, as compared with the first month of the year. The total for February was $1,491,499, while the January total was $1,653,472. The record for February, however, shows a material increase over that of the same period in 1910. The following is a list of the principal countries to which electrical products were sent in February of this year:

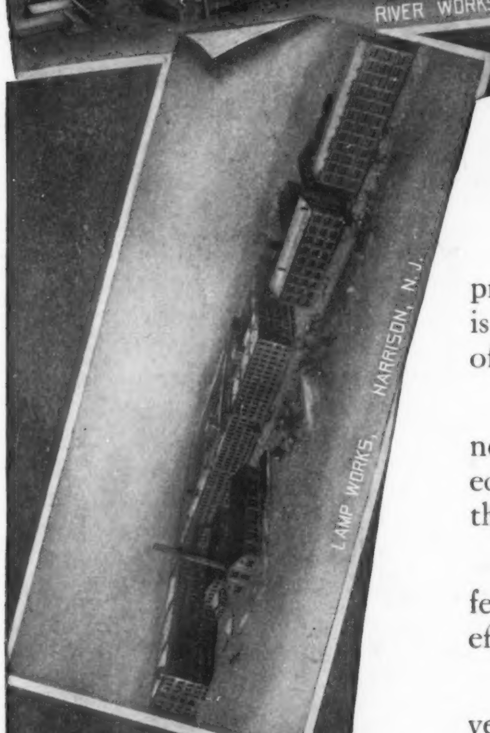
Exported to—	Electrical Appliances.	Electrical Machinery.
United Kingdom.....	$32,170	$49,331
Canada	268,238	130,002
Mexico	85,551	67,437
Cuba	42,274	30,180
Brazil	187,730	2,873
Rest of South America	101,030	33,838
Japan	71,316	109,048

Charging Car for Signal Batteries.—Most of the mileage of the Harriman lines is protected by automatic signals. At the end of last year there were 6,125 miles of single track thus equipped. The problem of charging the storage batteries used in this system is no small one. Where possible, current is obtained from local companies. In other cases charging stations are provided, consisting of a generator operated by a gasoline engine. In addition to these, a charging car is used consisting of a box car, fitted with a generator driven by a gasoline engine, and auxiliary apparatus, a battery room, and living quarters for the electrician in charge. This car has been in operation for three years, and handles 832 cells per month over a territory of 150 miles of single track.

Rubber Insulation Injured by Fungus Growths.—It has recently been discovered in Germany that when rubber insulation is inclosed in an iron tube, a fungus growth appears, which seems to be fostered by iron rust. This fungus in time breaks down the insulation. The only method of preventing it is to have the tube perfectly clean and bright, and to keep it perfectly dry by passing hot air through it.

General Electric Company

Largest Electrical Manufacturer in the World



Director of Electrical Progress

Behind—and, in a large measure, responsible for—the unprecedented progress that has made this the "Age of Electricity," is one company that is the acknowledged director and guide of the world's electrical progress.

The practical application of this marvelous force to every need is the work of an organization of 30,000 men and the equipment contained in modern factories, shown in part on this page.

No part of this progress is more satisfactory than the perfecting by this company of the Mazda Lamp, whose remarkable efficiency has made electric lighting possible in every home.

With electric lighting in the home a hundred other conveniences are available, electric fans, flatirons, stoves, toasters, motors and many other "servants-to-comfort," summoned and dismissed at the turn of a switch.

Electric light, heat and power is now as available in country homes as in city residences because of the development by this company of the self-contained Gasolene-Electric Generating Set.

Information on anything electrical can be obtained from the nearest office of this company.

Principal Office: Schenectady, N. Y.

Sales Offices in the Following Cities:

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Baltimore, Md.
Birmingham, Ala.
Boston, Mass.
Buffalo, N. Y.
Butte, Mont.
Charleston, W. Va.
Charlotte. N. C.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Columbus, O.
Denver, Colo.
Erie, Pa.
Detroit, Mich. (Office of Sales Ag't)
Indianapolis, Ind.
Kansas City, Mo.
Los Angeles, Cal.
Macon, Ga.
Minneapolis, Minn.
Nashville, Tenn.
New Haven, Conn.
New Orleans, La.
New York, N. Y.
Philadelphia, Pa.
Pittsburg, Pa.
Portland, Ore.
Richmond, Va.
Salt Lake City, Utah
San Francisco, Cal.
St. Louis, Mo.
Seattle, Wash.
Spokane, Wash.
Syracuse, N. Y.

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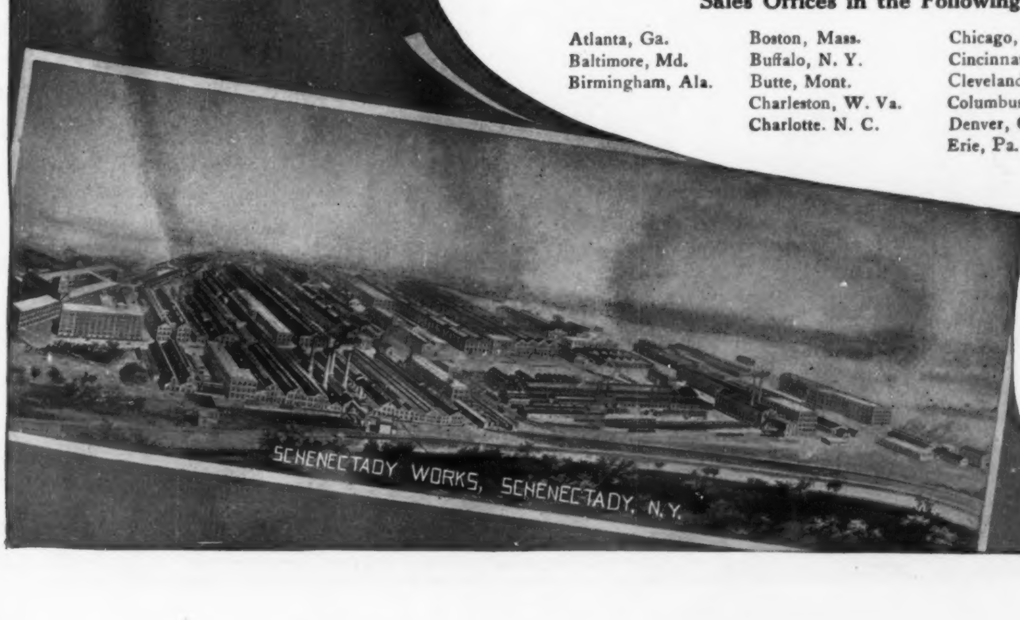

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